TECHNICAL MANUAL
OPERATION AND MAINTENANCE
DIGITAL MULTIMETER
MODELS
DM330 AND DD330

SER 1176

DYNASCIENCES
CORPORATION

INSTRUMENT SYSTEMS DIVISION

SUBSIDIARY OF Whittaker CORPORATION

OCTOBER 1969

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Figure 1-1. Model DM330 Digital Multimeter

SECTION 1

GENERAL DESCRIPTION AND SPECIFICATIONS

1-1. INTRODUCTION

1-2. This technical manual presents the general description, operation, theory, and maintenance instructions as well as parts lists, schematic and wiring diagrams for the Model DM330 and DD330 Digital Multimeters (see Figure 1-1), hereafter referred to as the multimeter.

1-3. DESCRIPTION

1-4. The multimeter is a bench-mounted (rack mount kit optional), dual slope digital multimeter. The Model DM330 measures DC volts, DC current, AC volts and Ohms. The Model DD330 is identical except for the omission of the AC volts measuring capability, and no AC VOLTS selector switch is included on the front panel (Figure 1-1). Internally, the multimeter construction consists of two printed circuit boards, Figure 1-2. The board directly under the top cover is the Digital Circuit Board A1 while the board near the bottom cover is the Analog Circuit Board A2. The Digital Circuit Boards for both models are identical, while the Analog Circuit Board for the DM330 mounts additional components required for the measurement of AC volts. At the bottom, below the Analog Circuit Board is a guard plate with holes to provide access to adjustments on this board. All Digital Circuit Board internal adjustments are accessible when the chassis is removed from the case. Power supply components are located internally at the back of the chassis. With the exception of the rear mounted fuses, all controls are mounted on the front panel. Stowing brackets are provided on the rear panel which provide convenient storage for the power cord when the multimeter is not in use.

1-5. SPECIFICATIONS

1-6. Leading specifications for the Model DM330 are given in Table 1-1. The Model DD330 specifications are identical except as noted in the table.

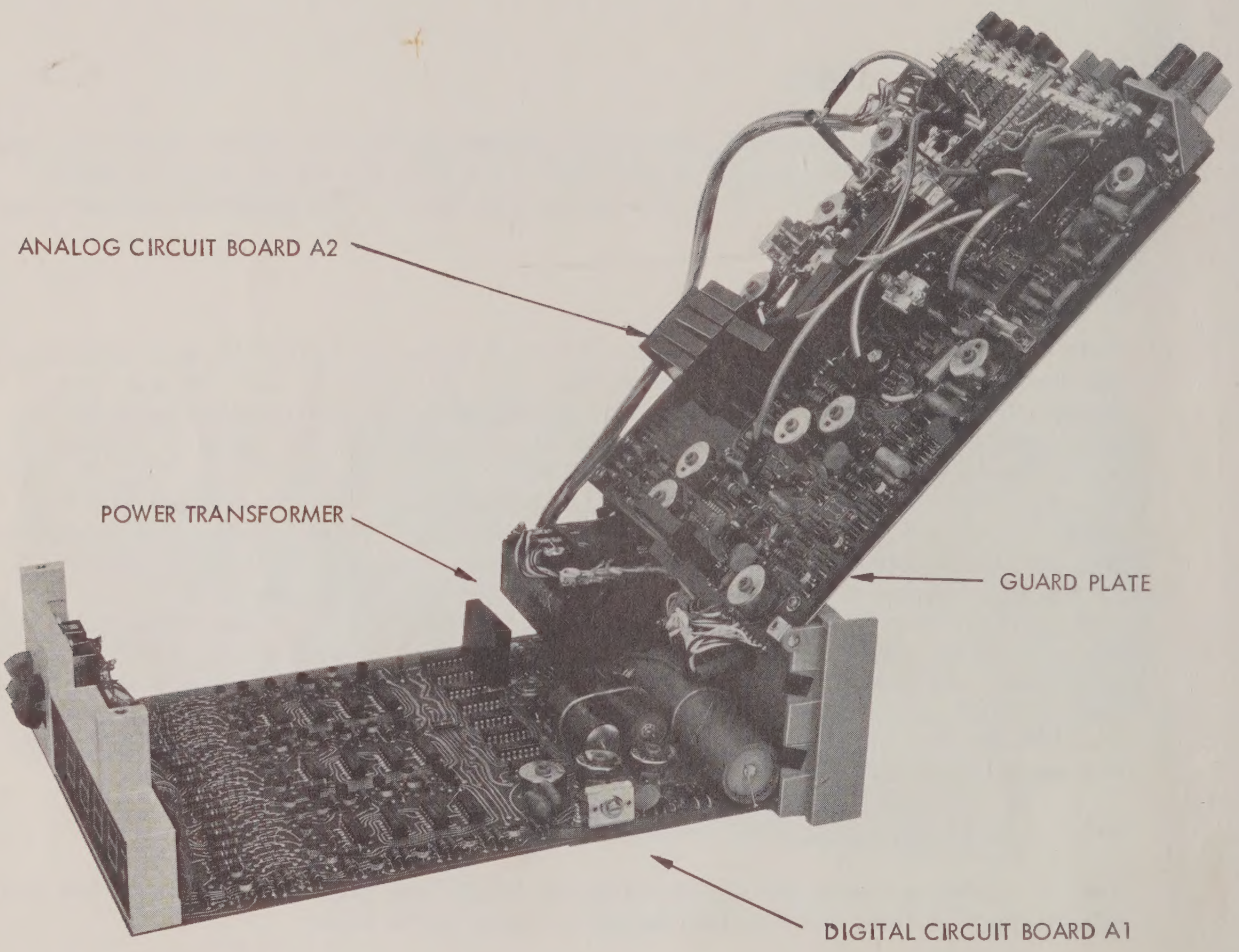


Figure 1-2. Multimeter Chassis Open for Servicing

Table 1-1.

Multimeter Specifications

Display	3 full digits, reads 1500 at full scale. Polarity, range and units. AC volts (DM330 only).
Ranges:	DC volts: ±1 MV/digit to 1000 volts full scale. DC input resistance 10 megohms constant. DC current: ± 1mA/digit to ±10 MA full scale (higher ranges optional). Absolute maximum input current, 25 MA on any range, or 30 times range, whichever is less. AC volts (DM330 only): 50 Hz to 10 KHz with 10 megohm input resistance shunted by 110 pf. Resistance: 1 ohm/digit to 10 megohms, full scale. Maximum voltage across unknown resistor is 10 VDC at full scale.

Nominal Current Through Unknown Resistor	Resistance Range
1 μA	10 MEGOHMS
10 μA	1 MEGOHM
100 μA	100 K OHMS
1 MA	10 K OHMS
10 MA	1 K OHMS

Ranging:	Pushbutton selected.
Accuracy:	±0.1% of reading ±1 digit on DC, K ohms and Current functions full scale. 1% of full scale on AC volts (DM330 only)*.
Setting Time:	0.1 sec to within 0.1% of full scale on DC, K ohms and Current functions. Less than 2 seconds for AC volts (DM330 only).
Normal Mode Rejection:	Infinite at 60 Hz and multiples thereof. ** Infinite at 50 Hz and multiples thereof for HO3 option. **
Common Mode Rejection:	Greater than 100 db up to 1 KHz with 1K ohm source imbalance. Greater than 120 db at DC.
Operating Temperature:	0°C to 55°C.
Power Requirements:	115 or 230 volts AC rms (as specified at time of purchase) HO3 option. 47-440 Hz, 15 watts max
Input Isolation from earth ground:	500 VDC or peak AC.
Weight:	7-1/2 pounds
Dimensions:	8-1/2" wide x 3-1/2" high (3-7/8" with rubber feet) x 12" deep.

* Over temperature range 15°C to 35°C.

** ASA Test Conditions.

SECTION 2

INSTALLATION AND OPERATION

2-1. GENERAL

2-2. This section presents a description of installation procedure and tabulates the functions of the various operating controls on the multimeter front panel. This information is followed by an analysis of the techniques used in performing the various measurements of which the multimeter is capable.

2-3. INSTALLATION

2-4. The table mounted instrument is provided with four rubber feet and a carrying handle which may be positioned to provide a degree of tilt for ease of front panel observation. The multimeter is designed to operate from 115 or 230 volts rms, 47-440Hz at 15 watts. The optional 115 or 230 volt operation, one of which is specified at time of purchase, is accomplished by proper jumper connections to the primary of the power transformer as shown on Drawing 5007309 in Section 6. Reference should also be made to Drawing 660201 in the event that the alternate connection is required after purchase. A polarized AC line cord is provided.

2-5. CONTROLS AND INDICATORS

2-6. The indication and/or function of each operating control and indicator is described in Table 2-1. Reference should be made to Figure 2-1 in conjunction with the table.

2-7. OPERATION

2-8. Turn-on and Preoperational Checks. Before installing the power cable at a convenience outlet, the a-c input voltage should be known. The multimeter is wired for 115Vrms unless otherwise noted on the name plate. CAUTION: Look at nameplate to be sure multimeter is not wired for special input voltage. In the event that primary power is 230Vrms, refer to paragraph 2-4.

2-9. Once the proper a-c voltage is assured, plug in power cord, place POWER switch in ON position and allow a 30-minute warmup period.

2-10. As a final check before use, the black and red terminals should be shorted, the VDC pushbutton pressed, and the RATE control placed in FAST position. Adjust the ZERO control until the numerical readout shows 000 and the polarity symbol shifts between + and - in a random manner. Finally, place POWER switch in TEST and note that all seven segments of each digit are lighted. Adherence to this procedure with the numerical display and polarity as noted ensures that the multimeter is operating correctly and is ready to perform the various measurements described in this section.

2-11. DC Voltage Measurement (0-1000 VDC). Four ranges are available in this mode: 0-1, 0-10, 0-100 and 0-1000 (10^0, 10^1, 10^2, 10^3), with 50% overrange on any range. This mode of measurement is performed in the following manner:

Table 2-1.

Controls and Indicators

Control or Indicator	Function
Numerical Display	Most significant figure indicates "1" or 10^3. Does not indicate for smaller measurements. Second most significant digit indicates "0" to "9" until most significant digit goes "0" to "1", then second most significant digit indicates "0" to "5". Last two least significant digits indicate "0" to "9".
Decimal Point Display	Displayed in correct position for DC volts, DC amps, ohms and AC volts (DM330 only).
Vdc, Adc, KΩ, or Vac (DM330 only) Display	Measurement parameter display selected by VDC, AMPS DC, OHMS or VAC (DM330 only) function selector switch.
-Polarity Display	Automatically displays polarity of VDC or DC AMPS measurement. Displays without sign are assumed to be positive.
VAC pushbutton (DM330 only)	Selects AC voltage measurements when option is included. Locks out remaining function selector switches.
VDC pushbutton	Selects DC voltage measurement. Locks out remaining function selectors switches.
AMPS DC pushbutton	Selects direct current measurement. Locks out remaining function selector switches.
OHMS pushbutton	Selects resistance measurement. Locks out remaining function selector switches.
10MEG, 1UA, 1V range selector switch	Selects 10^7 ohms, 10^{-6} amps or 10^0 volt measurement range depending on selected function switch. Lock out remaining range selector switches.
1MEG, 10UA, 10V range selector switch	Selects 10^6 ohms, 10^{-5} amps or 10^1 volts measurement range depending on selected function switch. Locks out remaining range selector switches.
100K, 100UA, 100V range selector switch	Selects 10^5 ohms, 10^{-4} amps or 10^2 volts measurement range depending on selected function switch. Locks out remaining range selector switches.
10K, 1MA, 1KV range selector switch	Selects 10^4 ohms, 10^{-3} amps or 10^3 volts measurement range depending on selected function switch. Locks out remaining range switches.

Table 2-1.

Controls and Indicators (Continued)

Control or Indicator	Function
1K, 10MA range selector switch	Selects 10^3 ohms or 10^{-2} amp measurement range depending on selected function switch. Locks out remaining range selector switches.
RATE control	Allows measurement to be displayed for selected period: SLOW (1 reading/sec), FAST (10 readings/sec) or HOLD, which maintains the previously registered measurement indefinitely.
OVER RANGE indicator	Indicates when full scale capacity (1500) is exceeded.
POWER switch	Applies or removes primary AC power in ON and OFF positions. TEST position permits illumination of entire display in order to check that all segments light.
ZERO screwdriver adjustment	Provides zero adjustment on DC volts as indicated by 000 display when red, black and GUARD input terminals are shorted.
Red and black input terminals	Input high and input low terminals
GUARD (white) terminal	Permits in excess of 100db common mode rejection with 1 Kohm source imbalance, DC to 1 Khz.
Fuse F1 (rear panel)	Fuse, Slo Blo, 1/2 amp, 3AG, 125V. CAUTION: Use Slo Blo, 1/4amp, 3AG, 250V with 230 volt AC option.
Fuse F2 (rear panel)	Fuse, Fast Acting, 1/32 amp, 3GX, 250V.
Power Cord (rear panel)	3-conductor, 6-ft, power cord with polarized receptacle.

Figure 2-1. Multimeter Front Panel Controls and Indicators

A. Connect standard-type voltmeter leads between red and black terminals and the DC voltage source being measured. When shielded leads are used, connect the shield to the GUARD terminal. For most measurements GUARD should be connected to the black terminal. If common mode voltages are present, GUARD should be connected to the source of the common mode voltage.

B. Depress the VDC pushbutton.

C. Known Range. When the range is known, select the corresponding range pushbutton.

D. Unknown Range. When the range of the quantity to be measured is unknown, press the highest range pushbutton, then move down to the next lower range, progressively, until the OVER RANGE indicator lights, then advance to the next higher range.

E. Observe numerical display. Polarity and decimal point are determined automatically.

NOTE

The black terminal is isolated from earth ground, so knowledge of the polarity of the measured voltage or its reference to earth ground is not required. True polarity is automatically determined by the multimeter and is indicated on the display.

2-12. AC Voltage Measurement. (DM330 ONLY). The AC converter (DM330 only) provides four ranges of measurement and also provides the 50% overranging feature. The instrument functions as an average sensing meter calibrated to read out the rms of a sine wave input. The four available ranges are 0-1, 0-10, 0-100, and 0-1000 volts rms full scale with 50% overange. Measurements are made as follows:

A. Connect shielded test leads from red and black terminals across the voltage source. The shield should be connected to GUARD, which will in turn be tied either to the black terminal or to the source of common mode voltage, if any.

B. Depress VAC pushbutton. The symbol Vac will appear on the display.

C. Known Range. Should the range be known, select this range by pressing the appropriate range pushbutton.

D. Unknown Range. When the range of the quantity to be measured is unknown, press the highest range pushbutton, then move down to the next lower range, progressively, until the OVERRANGE indicator lights, then advance to the next higher range.

E. The rms value is automatically indicated on the numerical display. The decimal point is automatically positioned and the indicated voltage is the rms value of the AC voltage across the terminals, assuming a sinusoidal input waveform.

2-13. Resistance Measurement. When in this function, the multimeter provides ranges of 0-10 Megohms, 0-1 Megohm, 0-100K, 0-10K and 0-1K with 50% overranging on all ranges. The measurement is performed as follows:

A. Use shielded leads for measurements over 10K ohms and connect the shield to GUARD (white) terminal. If a shield is placed around the resistance being measured, this shield should be connected to the GUARD terminal. In any case, the GUARD terminal should be connected to the black (input low) terminal.

B. Depress OHMS pushbutton. The symbol KΩ will appear on the display.

C. Known Range. Should the range be known, press the appropriate range pushbutton.

D. Unknown Range. When the range of the resistance to be measured is unknown, press the highest range pushbutton, then move down to the next lower range, progressively, until the OVER RANGE indicator lights, then advance to the next higher range.

E. Observe the numerical indicators. The indication is the resistance measured in thousands of ohms, and the decimal point is positioned automatically.

2-14. Direct Current Measurement. Five ranges are available in this mode: 0-1UA, 0-10UA, 0-100UA, 0-1MA and 0-10MA. The measurement procedure is as follows:

A. Use shielded leads to perform this measurement. Connect current source to the red and black terminals and shield to the GUARD terminal. Connect GUARD terminal to the black terminal.

B. Known Range. When the range is known, press the appropriate range pushbutton.

C. Unknown Range. When the range is unknown, press the highest range pushbutton, then move down to the next lower range, progressively, until the OVER RANGE indicator lights, then advance to the next higher range.

D. Observe the numerical indicators. The indication is the direct current in Ma or Ua and polarity as shown on the display. The decimal point is positioned automatically.

WARNING

DO NOT APPLY VOLTAGE TO INPUT CONNECTOR WHEN IN THE OHMS OR AMPS FUNCTIONS OF THE DIGITAL MULTIMETER. SERIOUS DAMAGE TO THE CIRCUITRY SHALL RESULT.

SECTION 3

THEORY OF OPERATION

3-1. INTRODUCTION

3-2. The purpose of this section is to present the theory of operation of the multimeter. This is accomplished, first, by describing the basic concept of the measuring function. Following this, the instrument is analyzed on a block diagram level. This is accomplished by first describing a typical cycle when measuring a D-C voltage whose range and polarity (+10.00 volts) are known and this range has been manually selected by the front panel pushbuttons. Next described is the measurement of a D-C voltage whose amplitude is greater than the selected range and an OVER RANGE indication is obtained on the front panel. The text then goes on to analyze each of the areas shown on the block diagram and of the power supply. Extensive use is made of partial logic diagrams and timing charts. The user of the manual should make frequent reference to the schematic diagrams included in Section 6.

3-3. BASIC CONCEPTS

3-4. The multimeter utilizes the time-ratio measurement technique shown in the diagram, Figure 3-1.

3-5. The input voltage E_{in} is connected to the integrator consisting of R, C, and A for the time T_1 as shown on the waveform which shows how voltage E is produced on the output of A during time interval T_1. Mathematically, E is expressed in the conventional integrator equation:

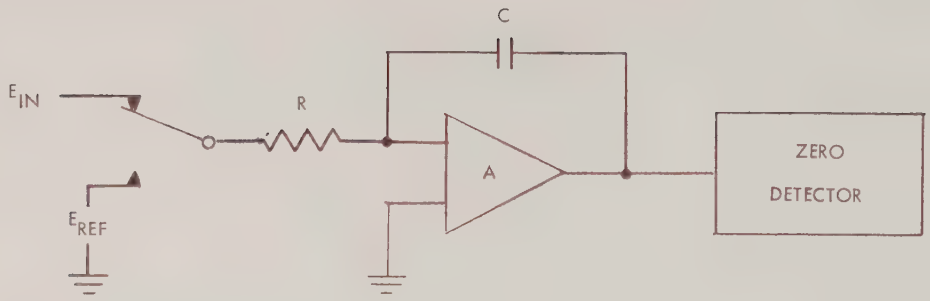
$$E = \frac{-1}{RC} \int_0^{T_1} E_{in}\,dt \qquad (1)$$

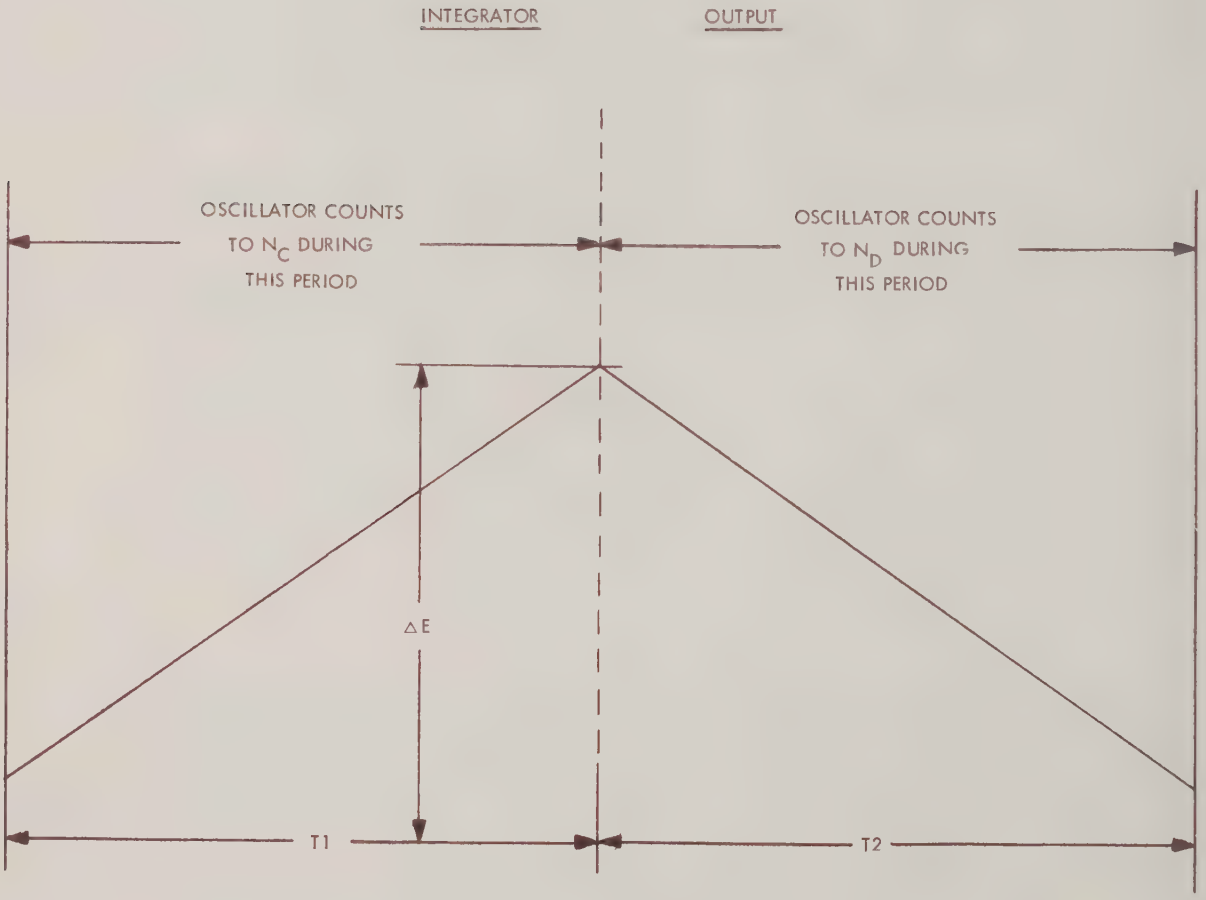
If E_{in} is constant, equation (1) simplifies to:

$$E = \frac{-E_{in} T_1}{RC} \qquad (2)$$

3-6. It should be noted that if E_{in} is not constant, then E represents the true bipolar time integral over sampling time T_1 and is zero for 60 Hz, (50 Hz for HO3 option). This fact is responsible for the high inherent noise rejection of the multimeter without slow filters, dead zone, foldover errors, or errors proportional to the number of zero crossings of E_{in} during time T_1. Upon initiation of T_1, an oscillator of frequency f_0 starts advancing a digital counter until a fixed number of counts N_C is accumulated.

3-7. When fixed count N_C is reached, time interval T_1 is terminated and the counter is reset to zero. A precision voltage reference E_{ref} is then connected to the integrator input at the start of time interval T_2. Since E_{ref} is opposite in polarity to E_{in}, the output of the integrator falls until zero volts is reached, at which time the zero crossing detector terminates time interval T_2. The counter thus accumulates oscillator counts until the end of interval T_2, at which time it will contain a number of counts N_D, which is the number to be displayed.





330-4

Figure 3-1. Measurement Principles

Since T_2 ends at the voltage level where T_1 starts, the changes in voltage at the output of the integrator must be equal and opposite, thus:

$$E = \frac{-E_{ref} T_2}{RC} \tag{3}$$

Equating quantities equal to E:

$$\frac{E_{ref} T_2}{RC} = \frac{E_{in} T_1}{RC} \tag{4}$$

Cancelling the RC terms and rearranging:

$$T_2 = \frac{E_{in} T_1}{E_{ref}} \tag{5}$$

Since T_1 is determined by a fixed number of oscillator counts N_C, then:

$$T_1 = \frac{N_C}{f_0} \tag{6}$$

Where f_0 is the oscillator frequency.

Similarly:

$$T_2 = \frac{N_D}{f_0} \tag{7}$$

Substituting the equivalents of T_1 and T_2 in equation (5):

$$\frac{N_D}{f_0} = \frac{E_{in} N_C}{E_{ref} f_0} \tag{8}$$

Cancelling f_0:

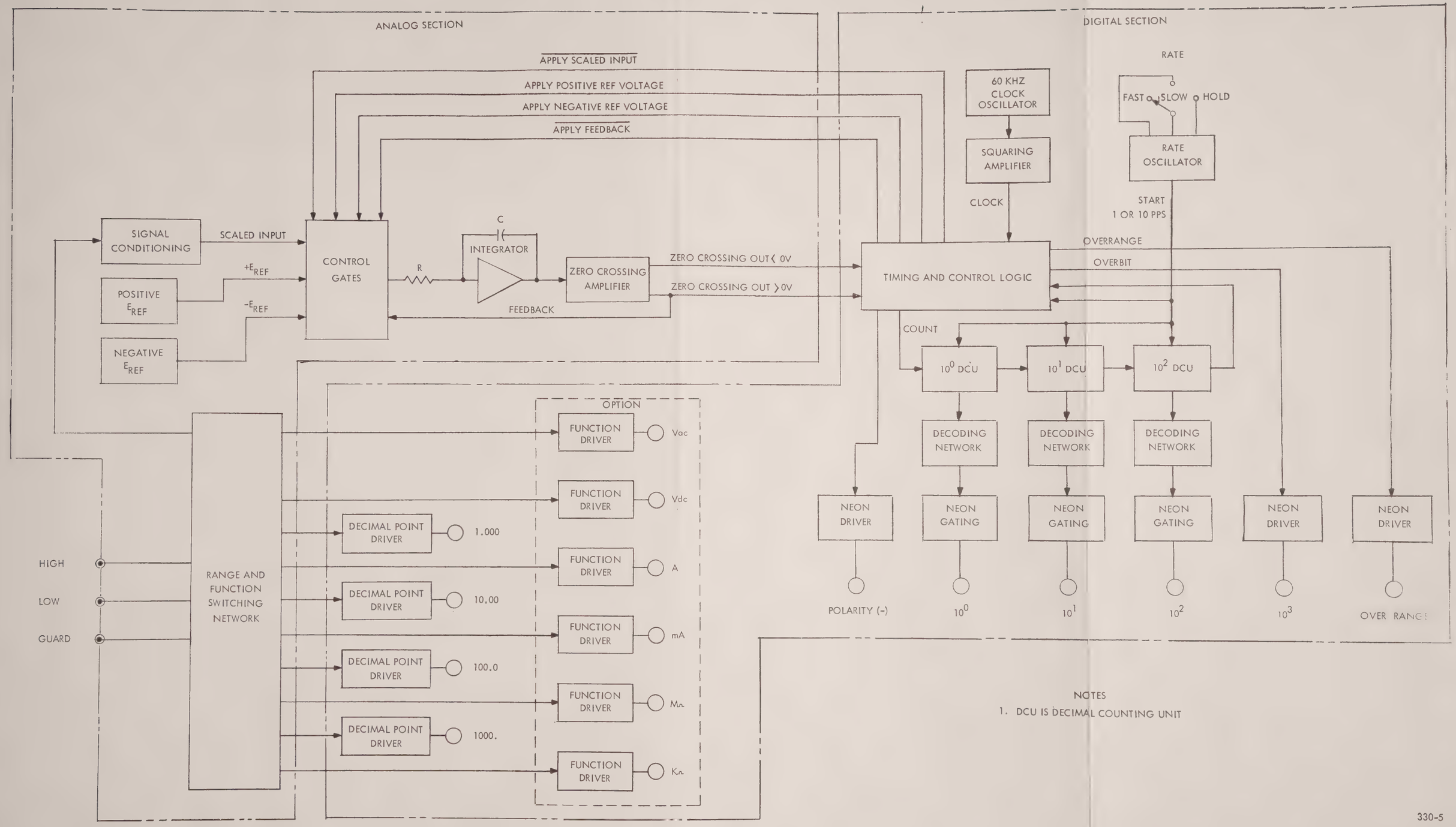
$$N_D = \frac{E_{in} N_C}{E_{ref}} \tag{9}$$

This important equation (9) shows that the number displayed is affected only by N_C, an invariant digital number, E_{ref}, a precision voltage reference, and E_{in}, the voltage to be measured. The accuracy of measurement is totally unaffected by oscillator frequency f_0 or the RC components in the integrator, provided only that these quantities remain stable during a measurement.

3-8. The voltage reference is the only important error source; therefore, great care is taken to insure its stability. Selected, aged Zener diodes are used in a circuit that provides such a high degree of regulation that line voltage effects are negligible.

3-9. FUNCTIONAL DESCRIPTION

3-10. MEASUREMENT OF KNOWN VOLTAGE. The functions of the various circuit elements shown in the block diagram of the multimeter, Figure 3-2, are explained by describing



NOTES

1. DCU IS DECIMAL COUNTING UNIT

330-5

Figure 3-2. Model DM330 Digital Multimeter, Block Diagram

the measurement of a D-C voltage, the range of which is known. Figure 3-3 illustrates the integrator operation when determining the precise value of a voltage which is known to be approximately +5 volts. The VDC and 10V pushbuttons are operated in order to accomplish this measurement and the voltage is applied between the high (red) and low (black) terminals on the front panel.

3-11. Measurement cycles are initiated as soon as power is applied to the multimeter and are continuous at the frequency established by the RATE control in conjunction with the rate oscillator. These START pulses are applied to the timing and control logic block and are also used to reset the DCUs (decimal counting units). The timing and control logic circuits are the source of all subsequent timing signals used in the measurement cycle. Subsequent events occur as follows:

A. The START pulse applied to the timing and control circuits develops $\overline{\text{APPLY SCALED INPUT}}$ which is taken to the control gates and causes the scaled input voltage from the range and function switching and signal conditioning circuits to be applied to the integrator. The integrator then performs as described in paragraph 3-3.

B. Simultaneously, the START pulse causes the CLOCK signal derived from the 60 KHz oscillator and squaring amplifier to be gated to the decade counter as a symmetrical square wave COUNT input. The decade counter is filled to the 1000 count (10^2), at which time a CARRY pulse is applied from the 10^2 DCU to the timing and control circuits which terminates time interval T_1 and initiates time interval T_2. Also, when the integrator departs from zero crossover at the start of time interval T_1, a ZERO CROSSING AMP OUT < 0V is developed by the zero crossing amplifier and is processed in the timing and control circuits to establish a polarity indication (no sign on the display). The decimal point position is determined by the actuated range switch.

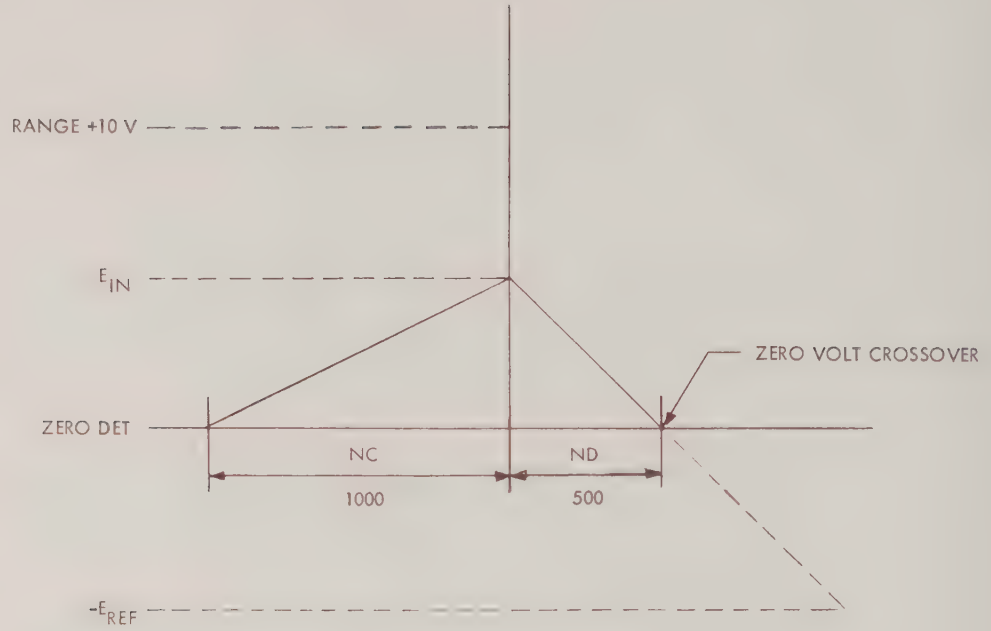
C. The first 1000 count performs the following functions:

1. Causes the $\overline{\text{APPLY SCALED INPUT}}$ to terminate, thus removing the scaled input signal from the integrator.
2. Starts period T_2 by initiating the APPLY NEGATIVE REFERENCE VOLTAGE. This signal gates the negative E_{ref} voltage to the integrator.

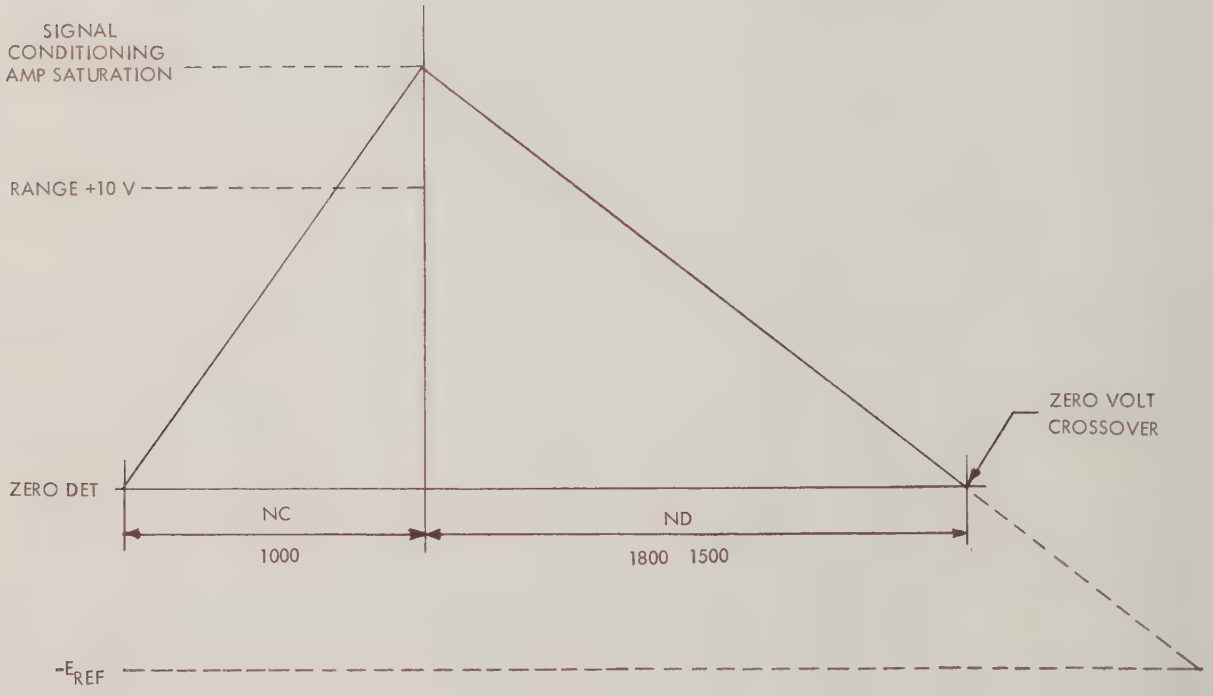
D. When the integrator output decays to the zero crossover point at count 1500, a zero crossing amplifier output terminates time interval T_2. At this time, the following events occur:

1. Time interval T_3 is initiated and lasts until the occurrence of the next START pulse.
2. $\overline{\text{APPLY FEEDBACK}}$ signal is applied to the control gates and places a short circuit around the integrator and zero crossing amplifier, thus clamping the outputs to zero volts until the occurrence of the next START pulse.

3-12. This concludes one cycle of measurement. This measurement sequence requires 25 milliseconds, whereas the START pulse rate allows approximately 100 milliseconds or 1 second per measurement. Display time for the 5.00 volt measurement is thus approximately 75.0 milliseconds or 975.0 milliseconds per cycle depending on the position of the front panel RATE switch.



CORRECT RANGE SELECTED



RANGE TOO LOW (OVER RANGE)

330-6

Figure 3-3. Measurement Function

3-13. In the event that a negative voltage is measured, ZERO CROSSING AMP OUT > 0V is developed and provides for gating of $+E_{ref}$ during time T_2 and the display of a - sign.

3-14. OVER RANGE MEASUREMENT. The multimeter is capable of making a measurement of up to 50-percent over the selected range. However, when this percentage is exceeded, the OVER RANGE indicator on the front panel becomes lighted. This is accomplished in the timing and control circuits. When the DCUs reach a 1500 count, a second carry pulse, of opposite polarity is developed by the 10^2 DCU which is logically ANDed with the OVERBIT and used to light the OVER RANGE indicator. Readings made when the OVER RANGE indicator is lit may be in error, and therefore, the instrument should be switched to a higher range.

3-15. FUNCTION DISPLAY. The function display is included with the multimeter, and provides a Vac, Vdc, μA, mA, MΩ, or KΩ display depending on the function selected by the front panel switches.

3-16. SIGNAL CONDITIONING. The basic circuits required for the conditioning of the input signal for DC, AC (DM330), ohms and D-C current measurement are shown in Figure 3-4 and make use of feedback amplifier AA1. The signal conditioning circuit accepts AC, DC, resistance and current and converts these quantities into a DC voltage which is scaled before application to the integrator.

3-17. When measuring DC, the signal conditioning amplifier is used simply as a gain of 10 buffer. The input voltage is applied to a precision 10 megohm divider, R1, and is scaled to one volt full scale at the input of the amplifier. The feedback resistor is made adjustable to provide a precise gain of ten at the amplifier output.

3-18. In the AC input voltage measurement (DM330 only), this voltage is applied to the precision divider string, R1, and is attenuated to provide a one volt rms full scale input to the AC converter. The AC converter consists of amplifier AA1 which has two diodes between its output and two feedback resistors which drive a summing resistor. The junction of the feedback resistors and the summing resistor is fed back to the negative input of the amplifier to provide negative feedback. In operation, the waveform is split between the two diodes so that the negative half cycles go through one diode and the positive half cycles go through the other. Since the positive and negative half cycles are split, the positive half cycles can be filtered in the R-C network composed of a two-pole passive filter. This D-C voltage is measured in the remaining analog circuits.

3-19. When measuring ohms, a voltage is applied to a standard resistor which is an element of voltage divider, R1. The other end of the standard resistor goes to the amplifier summing junction which is at a virtual ground potential due to the action of the amplifier. Therefore, current into the summing junction is constant. Since the amplifier draws no current or negligible current, all of this current must flow through the unknown resistor R_X in the feedback path of the amplifier. Therefore, the output voltage of AA1 in this mode is the standard current times the unknown resistor. This voltage is scaled to read directly on the kilohms range of the multimeter. To provide independence from variations in the standard voltage, this same voltage is used as the digital voltmeter reference. In this mode, the standard voltage quantity cancels out of the measurement equation and the accuracy of the kilohms function is dependent solely on the ratio of the unknown resistor to the standard resistor.

3-20. When in the current measuring mode, an element of precision voltage divider, R1, is connected as a feedback resistor around amplifier AA1. The input current is applied directly to the summing junction, flows through the standard resistor, and an output voltage

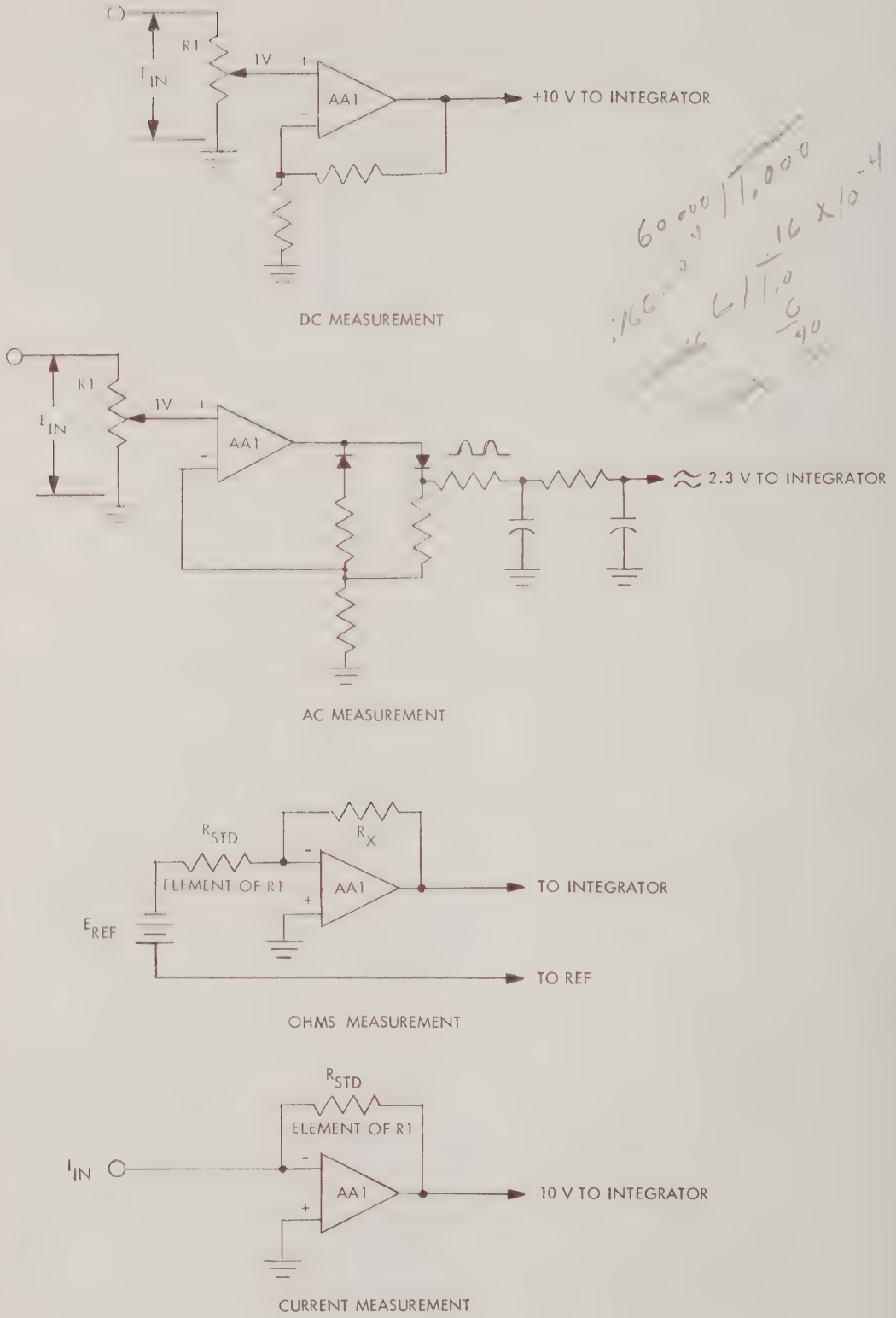


Figure 3-4. Simplified Signal Conditioning Circuits

is developed which is proportional to the input current. This method has the important advantage that, since the summing junction is at a virtual ground potential at all times, the input impedance is very nearly zero, the condition that is ideal for a current measuring device.

3-21. CIRCUIT ANALYSIS, DIGITAL SECTION

3-22. INTRODUCTION. The Model DM330 multimeter is divided into two major sections as shown on the block diagram, Figure 3-2: the analog section and the digital section. The digital section is discussed first and, to do this, the existance of ZERO CROSSING OUT < 0V (positive voltage measured) and ZERO CROSSING OUT > 0V (negative voltage measured) at start time T_1 and at the end of T_2 from the analog section is assumed.

3-23. 60 KHZ CLOCK GENERATOR. (Figure 3-5 and Drawing 5007309.) The signal counted during time intervals T_1 and T_2 is provided by the 60 KHz clock generator consisting of oscillator Q2 and squaring amplifier Q1. Inductance L1, capacitors C2, C4, and C6, and resistor R4 constitute a modified Colpitts oscillator circuit in conjunction with transistor Q2. The 60 KHz sine wave output is A-C coupled through C1 and scaled by R2 and R3. Negative pulse clipping is provided by CR1. The Q1 squared output is developed across R1.

3-24. RATE GENERATOR. The RATE pulse which determines the number of measurements made per second is developed by the circuit components associated with transistor Q58. A relaxation oscillator is formed by neon tube DS36, CR64, R77, R78 and C7 (paralleled by C8 in the SLOW position of the RATE switch). In operation, C7 charges through CR64, R77, and R78 to the firing voltage of DS36. At this point, DS36 fires and discharges C7 rapidly through R76 to R74 and the base of Q58. When the voltage drops below the sustaining potential of DS36, the neon extinguishes and the cycle is repeated. The discharge pulse is amplified and appears across load resistor R75 in the collector circuit of Q58. The negative-going output is applied through C6 to subsequent digital circuits. When the RATE switch is in the HOLD position, no output is obtained from the rate oscillator because R84 prevents C7 from charging to the firing potential of DS36.

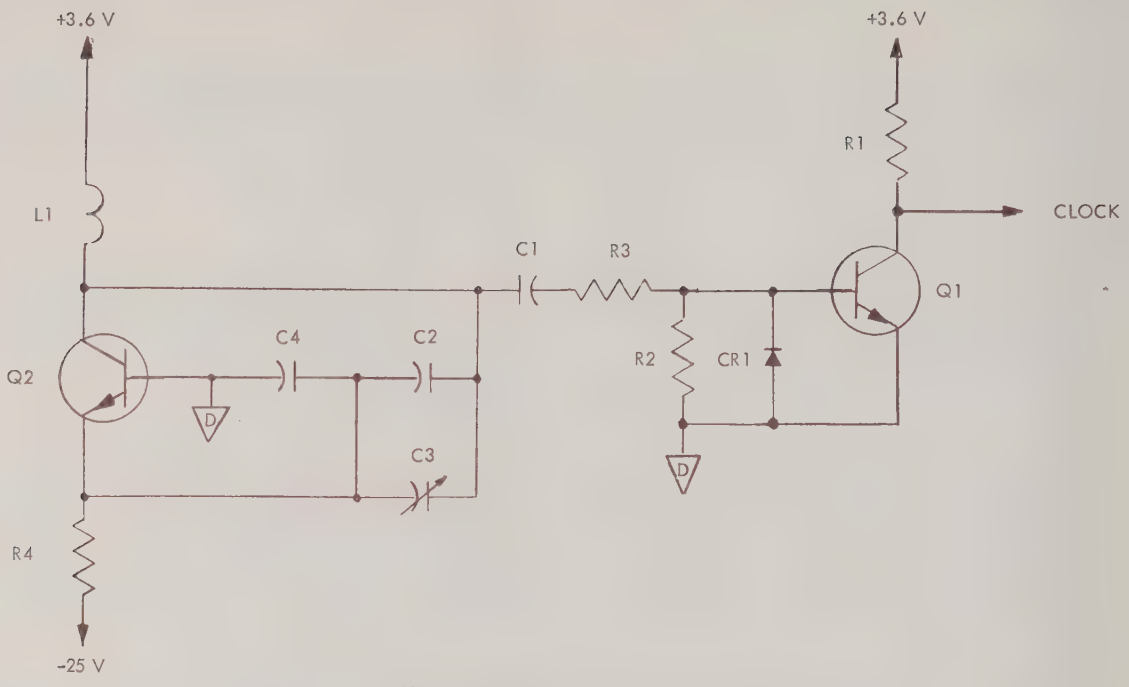
3-25. TIMING AND CONTROL LOGIC. (Figures 3-6, 3-7 and Drawing 660202.) First considered in the analysis of the timing and control logic is the circuit operation when the 10 volt DC range and function are selected and a positive 8.00 volt D-C signal is being measured. Time T_1 will therefore exist for the duration of 1000 clock pulses, while time interval T_2 will last for 800 clock pulses and the reference voltage will be negative. For this in-range condition, the following events occur:

A. The START pulse (waveform 1, Figure 3-7) from AB3A clears flip flops AF8A, AF8B and AG16A, B such that A11F output is high, A11E output is low, AF8B-8 is high, and AG16B output is high (waveforms 2, 3, 4, and 5).

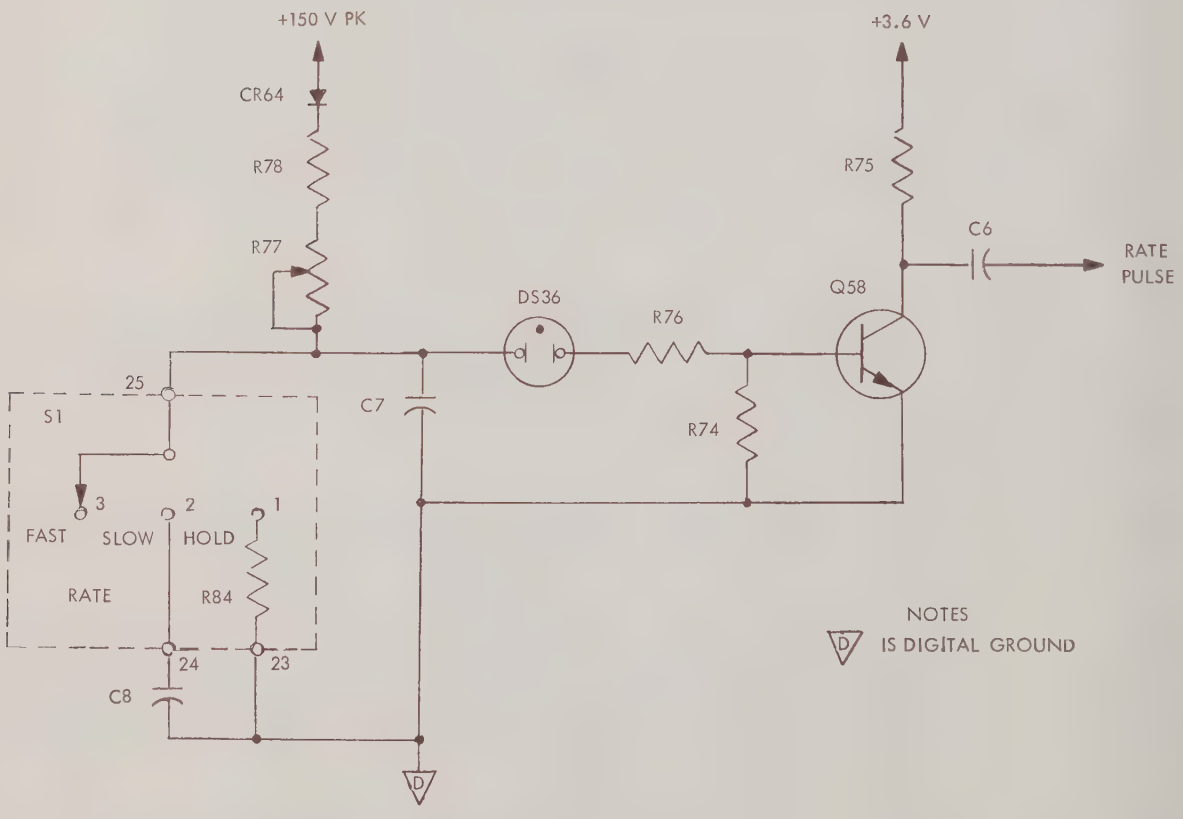
B. The CLOCK pulse (waveform 6) at AB3B is differentiated by R41-C5 and the negative-going leading edge (waveform 7) NORed with A11E sets the B-FF such that AG9D is low and AG9A is high (waveforms 8, 9). The high output of AG9A opens the APPLY FEEDBACK loop around the integrator. The low output of AG9D enables NOR gate AG2C to clock pulses which are taken through AB7B to the 10^0 DCU (waveform 10).

C. The output of AG9D is inverted in A11A and used to inhibit the +150V peak rectified voltage to the display neons (refer to paragraph 3-29).

D. The AG9D output is also NORed with A11E output in AG2A to provide $\overline{\text{APPLY}}$ SCALED INPUT and T_1 at A11C output and A11D output (waveform 12). The



60 KHZ CLOCK GENERATOR



RATE GENERATOR

330-8

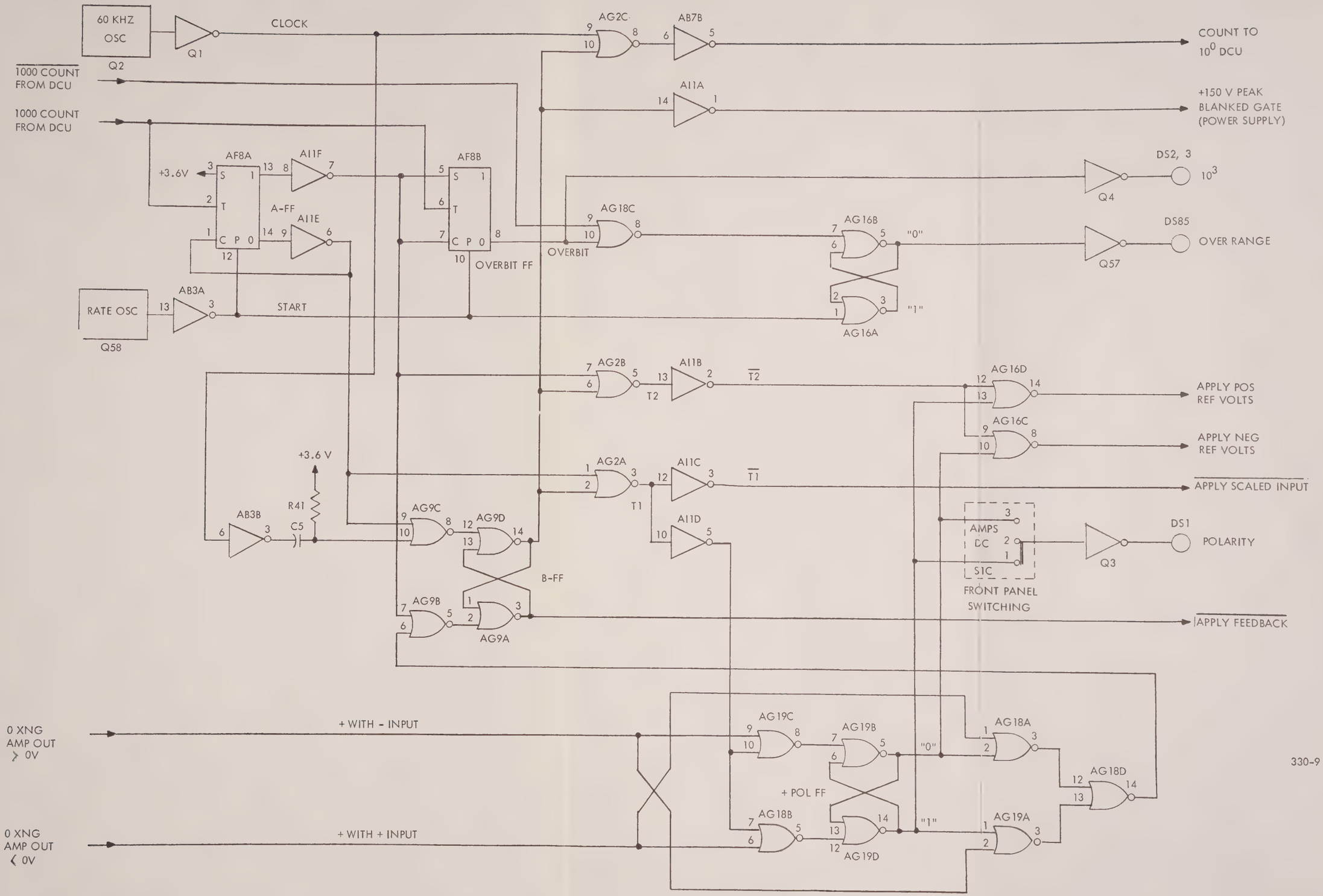


Figure 3-6. Timing and Control Logic Diagram

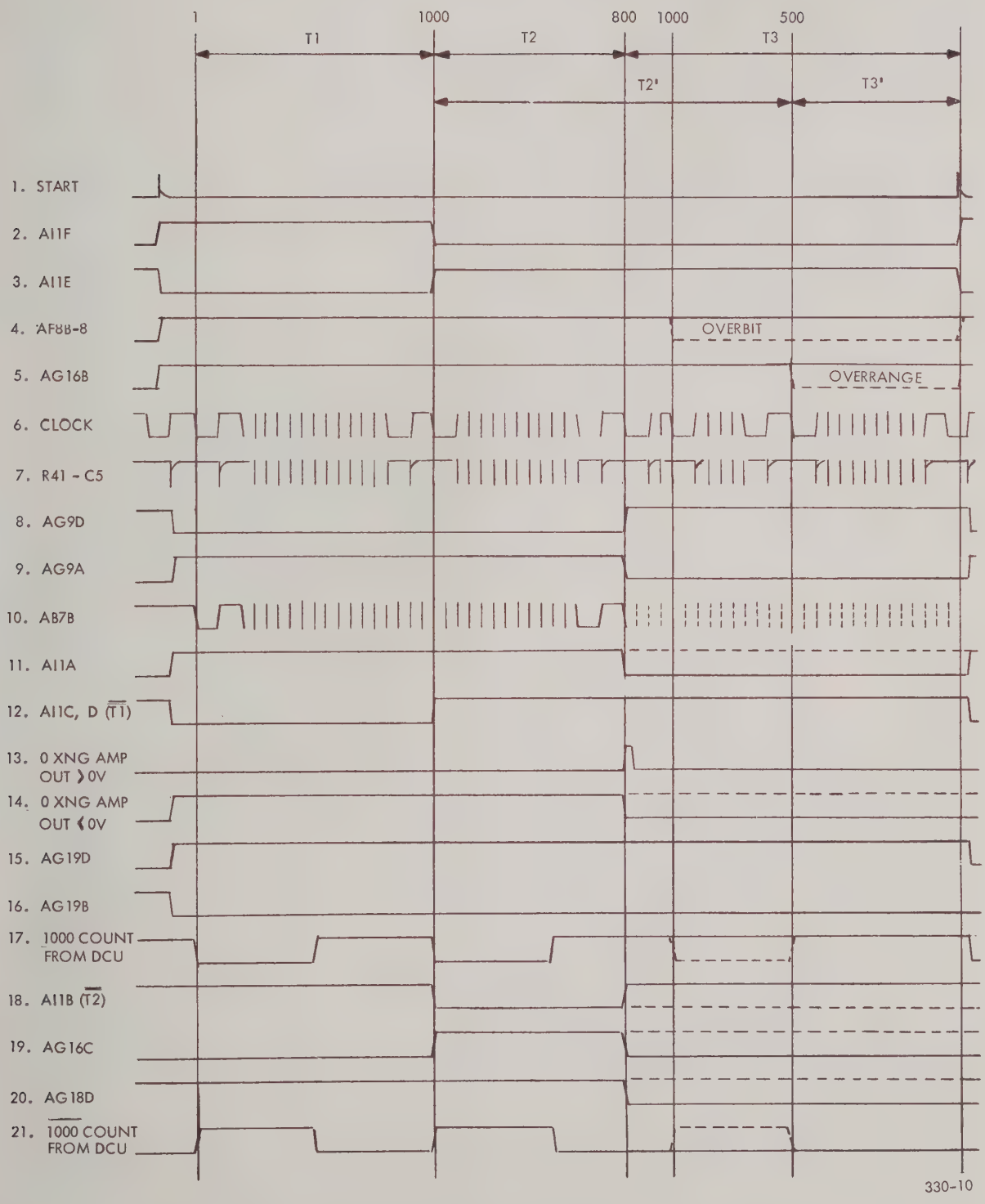


Figure 3-7. Timing and Control Logic Timing Diagram

low $\overline{\text{APPLY SCALED INPUT}}$ renders the signal input gate conductive allowing the integration of the input signal for the first 1000 count interval, T_1.

E. Since the measured voltage is positive, inputs from the zero crossing amplifier are realized during time interval T_1 which provide a ground input at ZERO XNG AMP OUT > 0V and a positive input at ZERO XNG AMP OUT < 0V (waveforms 13, 14).

F. The ZERO XNG AMP OUT > 0V (low) (waveform 13) is NORed with the $\overline{T_1}$ signal from A11D (waveform 12) in gate AG19C and sets the + POL flip flop such that AG19D output is high and AG19B output is low (waveforms 15, 16). Since AG19D output is high, inversion in neon driver Q3 prevents the negative polarity neon from glowing so no polarity indication (plus polarity) is obtained.

G. During T_1, the DCUs accumulate count pulses until the 10^2 DCU goes from 999 to 1000 and a low (waveform 17) is applied to the trigger inputs of AF8A and AF8B. Flip flop AF8A is toggled because its S input is high; therefore, A11F output goes low and A11E output goes high (waveforms 2, 3). Flip flop AF8B is not toggled because both the S and C inputs were high when the negative-going edge was applied to its T input (waveform 4). Note that, after this time, AF8A is disabled to accept further 1000 counts by virtue of the fact that the S and C inputs are both high.

H. The high output of A11E terminates time interval $\overline{T_1}$ from A11C, D (waveform 12). Since the A11E input is now high, this ends the signal integrating interval.

I. The low output of A11F (waveform 2) is NORed with the low output from AG9D (waveform 8) to provide $\overline{T_2}$ at A11B (waveform 18).

J. Quantity $\overline{T_2}$ is NORed with the low output of AG19B to provide APPLY NEG REF VOLTS from AG16C output (waveforms 18, 16, 19). This gates the negative reference into the integrator and causes the integrator output to decay towards zero volts. When the integrator output passes through zero, the ZERO XNG AMP OUT < 0V then goes to ground. At this time the counter will have accumulated 800 counts.

K. The low ZERO XNG AMP OUT < 0V is NORed with AG19B low in AG18A to provide a low output from AG18D to AG9B (waveform 20).

L. Both inputs at AG9B (waveforms 2, 20) are now low and cause AG9D to go high and AG9A to go low (waveforms 8, 9).

M. The high from AG9D terminates the count from AB7B to the 10^0 DCU (waveform 10), permits gating of +150V PK RECTIFIED BLANKED to the display from A11A (waveform 11), terminates time interval $\overline{T_2}$ from A11B, and terminates APPLY NEG REF VOLTS from AC16C (waveform 19).

N. The low output from AG9A (waveform 9) applies $\overline{\text{APPLY FEEDBACK}}$, thus placing a short around the integrator and introducing time T3.

O. Time interval T3 exists until the appearance of the next START pulse and the display indicates 8.00 Vdc during this interval. This completes one cycle of in-range measurement.

3-26. Next considered is an overrange measurement in which the measured voltage is very much greater than the 50-percent overrange allowed by the multimeter. The waveforms of interest in Figure 3-7 are those shown by broken lines during intervals T2' and T3'. Events occur as follows:

A. During time T2', the 10^0 DCU continues to count clock pulses until the 1000 count is again reached by the 10^2 DCU (waveform 10). This 1000 count (waveform 17) sets the overbit flip flop AF8B to provide a low OVERBIT output which enables NOR gate AG18C. This OVERBIT signal is inverted in Q4 and controls the most significant neon such that the display reads 1000 at this instant in time. The count continues and, when the 1500 count is reached, a $\overline{1000}$ count from the 10^2 DCU (waveform 20) occurs and activates AG18C, the output of which sets the overrange flip flop such that AG16B goes low (waveform 5). This output is inverted in Q57 and causes the OVER RANGE neon to glow, indicating that the 50-percent overrange capability is exceeded.

B. The count (waveform 10) continues until one of two events occurs: a second zero crossover occurs (waveform 14) when the integrator output decays to zero volts, or a new START pulse is developed (waveform 1). In either event, the digital indication is meaningless until the proper range is manually selected.

3-27. During the measurement of a negative polarity voltage, the operation of the logic is similar to that described in paragraph 3-25. The only difference is that a different set of gates are activated and the + polarity flip flop assumes the opposite state. As a result, APPLY POS REF VOLTS output is obtained and the negative polarity neon is caused to glow due to the state of AG9D and inverter Q3.

3-28. POWER SUPPLY CIRCUITS. (Figure 3-8 and Drawing 660202 .) The power supply provides +150V peak rectified blanked, -64V peak rectified, plus and minus 25 volts DC and +3.6 volts DC required by the multimeter.

3-29. In order to provide an interpretable readout, the readout is blanked during measurement times T1 and T2, and displayed only during time T3. The output of transformer T1 at terminals 15 and 11 is full-wave rectified by CR65 and CR68 and applied to transistor gate Q60. When transistor Q59 is turned on during times T1 and T2, the base of transistor Q60 is at ground and no 150 volt peak AC is applied to the digital display neons since this transistor is cut off. When Q59 is turned off during time T3, the display time between measurements, transistor Q60 performs as an emitter follower that applies peak +150 volts to the neons in the display.

3-30. The -64 volt peak rectified voltage is provided by transformer terminals 12-14 in conjunction with diode rectifiers CR66 and CR67.

3-31. The -25 and +25 volt DC supplies are provided by bridge rectifier CR69 through CR71 from transformer T1 terminals 7-5. The plus and minus voltage values are set by variable resistors R80 and R81.

3-32. The +3.6 volt DC supply consists of transformer winding 8-10 and diodes CR73 and CR74. The output D-C level is adjusted by variable resistor R82.

3-33. Jumper connections for 115 or 230 volt A-C line voltage operation are provided on the digital circuit board. When the POWER switch is in the TEST position, the +3.6 volt D-C supply is removed, thus causing all neons in the display to light for testing purposes.

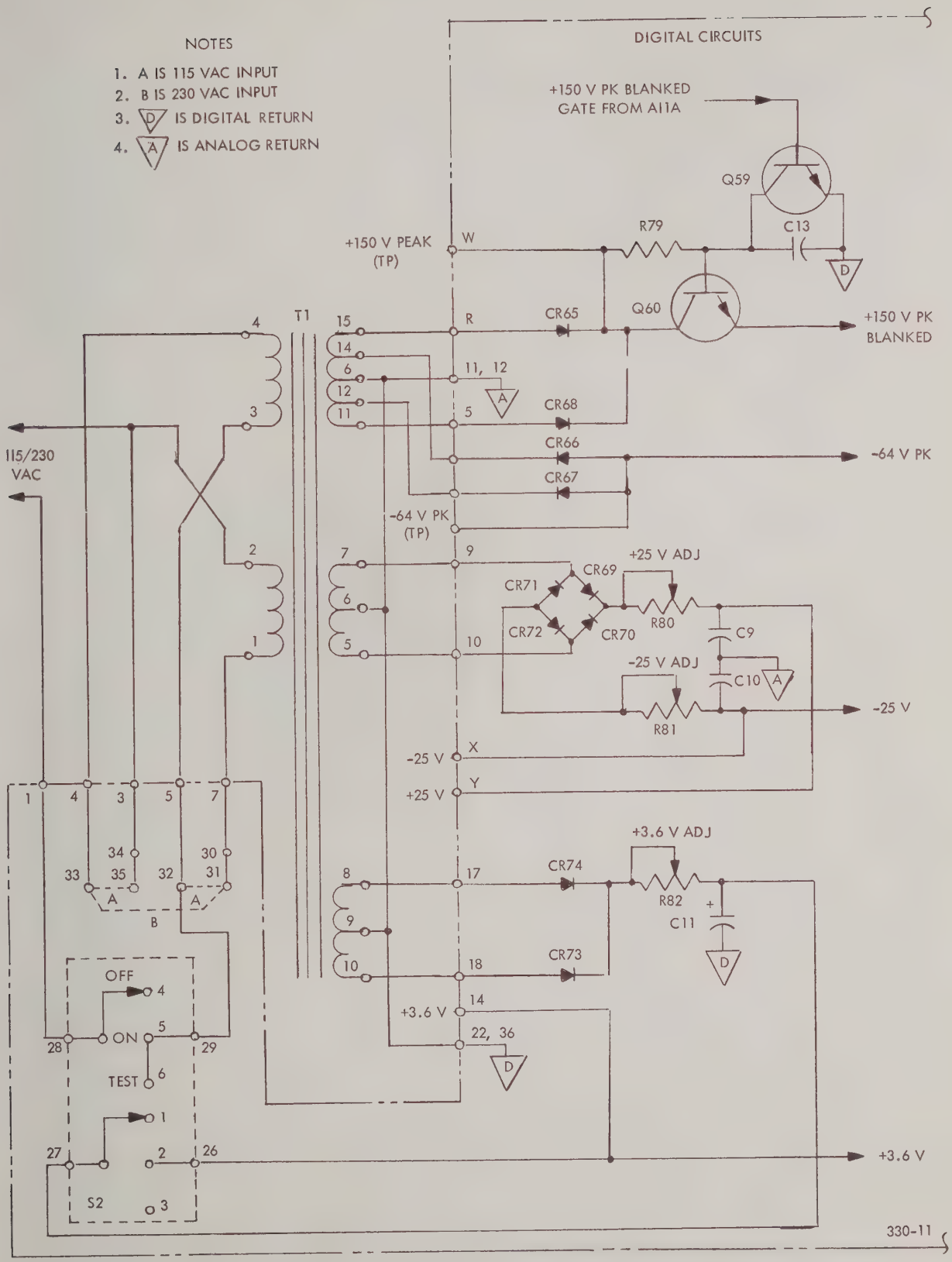


Figure 3-8. Power Supply Circuits

3-34. DECIMAL COUNTING UNIT. (Figure 3-9 and Drawing 660202 .) The logic and timing diagram for the least significant bit (10^0) shown on Figure 3-9 is typical of the remaining two DCUs used in the multimeter and is described here. The counter consists of four J-K flip flops AF4A through AF6B and inverters AB7B, AI5A through AI5C. The flip flops are cleared by a positive pulse applied to terminal P, and are caused to toggle from one state to the other by the negative-going edge of a trigger pulse applied to the T terminal when the S and C terminals are at ground level. When the S terminal is positive and the C terminal is low, subsequent triggers will cause the 1 output to go high if the flip flop is not already in that state. When the C terminal is positive and the S terminal is low, subsequent triggers will cause the 0 input to go high if the flip flop is not already in that state. When both the S and C inputs are positive, the trigger pulse has no effect on the state of the flip flop. The truth table for the flip flops in the DCU is shown.

	AF4A	AF4B	AF6A	AF6B
	N	M	L	K
0	0	0	0	0
1	0	1	0	0
2	0	1	1	0
3	1	1	1	0
4	1	0	1	0
5	0	0	0	1
6	0	1	0	1
7	0	1	1	1
8	1	1	1	1
9	1	0	1	1

1 state > 0.7V
0 state < 0.7V

3-35. The four flip flops are cleared at the start of T1 (end of T3) by the START pulse from the rate generator (paragraph 3-24). The first gated clock pulse after the START pulse initiates the counting function.

A. The negative-going edge of the first inverted clock pulse from AB7B is applied to the trigger input of flip flop AF4A, AF4B and AF6A; however, only AF4B is toggled because its S input is high while the remaining C inputs are high. The $\overline{M}$ output of this flip flop applies a low to AF6A-C.

B. The second clock pulse toggles AF6A only. Its $\overline{L}$ output applies a low to AF4A-C, while the L output (high) has no effect on AF6B.

C. The third clock pulse toggles AF4A such that $\overline{N}$ at AF4D-S is low but the clock has no effect on AF4B and AF6A.

D. The fourth clock toggles AF4B causing the M output to go low and the $\overline{M}$ output to go high. The input of AF4A-S is now low while the input at AF6A-C is high.

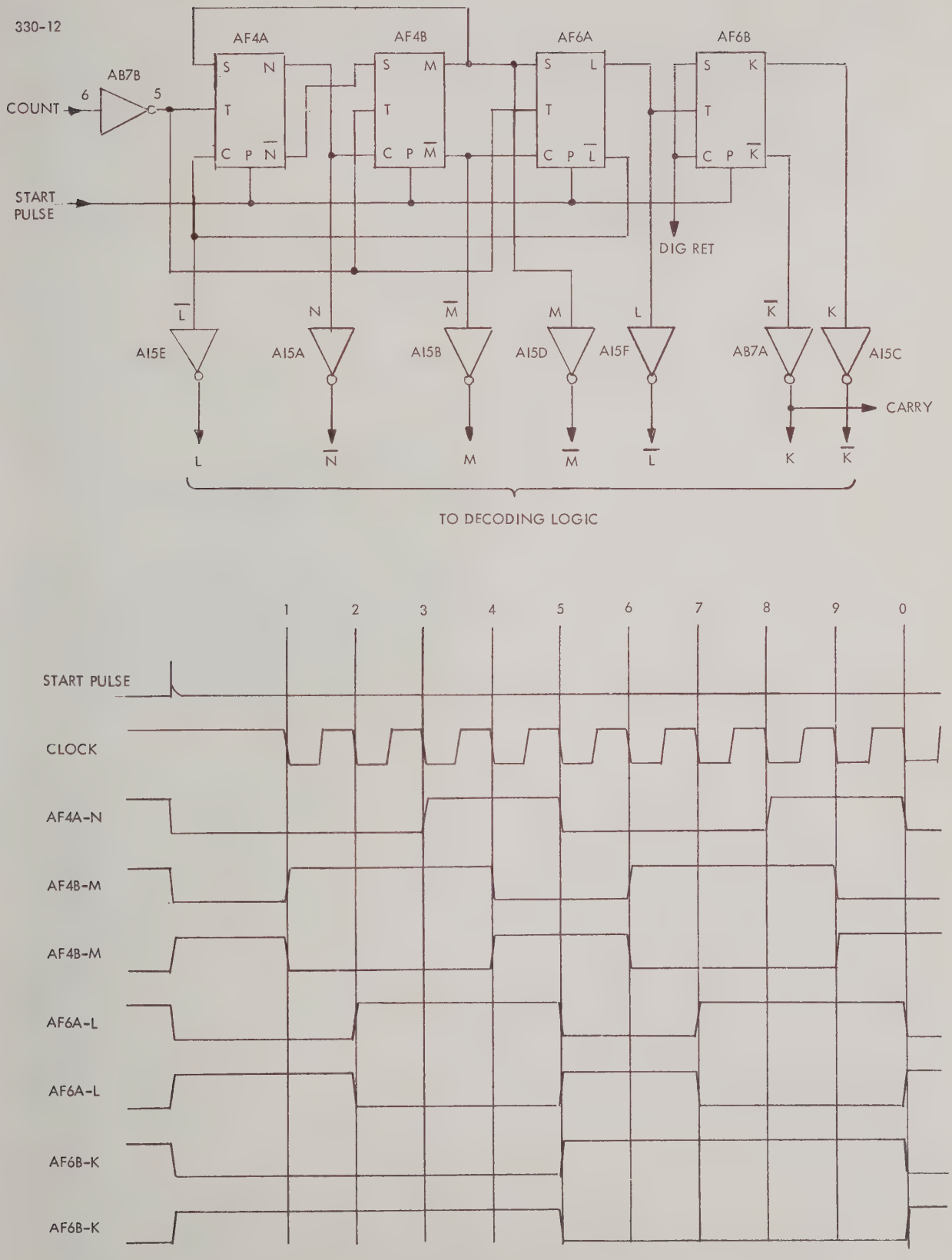


Figure 3-9. Decimal Counting Unit Logic and Timing

E. The fifth clock pulse causes AF4A and AF6A to toggle. Switching of AF6A-L from high to low triggers AF6B such that K is high and $\overline{K}$ is low.

F. The sixth clock reverses the state of AF4B. Flip flops AF4A and AF6A are unaffected. The inputs at AF4A-S and AF6A-S are now high, while that at AG6A-C is low.

G. The seventh clock toggles AF6A such that AF6B-T goes high. This flip flop and AF4A and AF4B remain in their existing states.

H. The eighth clock triggers AF4A while the remaining flip flops remain unchanged.

I. The ninth clock triggers AF4B only.

J. The tenth (0) clock toggles AF4A and AF6A. The AF6A-L low output in turn toggles AF6B. All flip flops are now in the cleared state and are ready for the next block of ten clock inputs.

K. Selected flip flop outputs are inverted in AI5A through AI5C and are applied to the decoding network. The negative-going output of AB7A is also applied as a carry pulse to the next more significant DCU, causing this decade to count every tenth clock pulse.

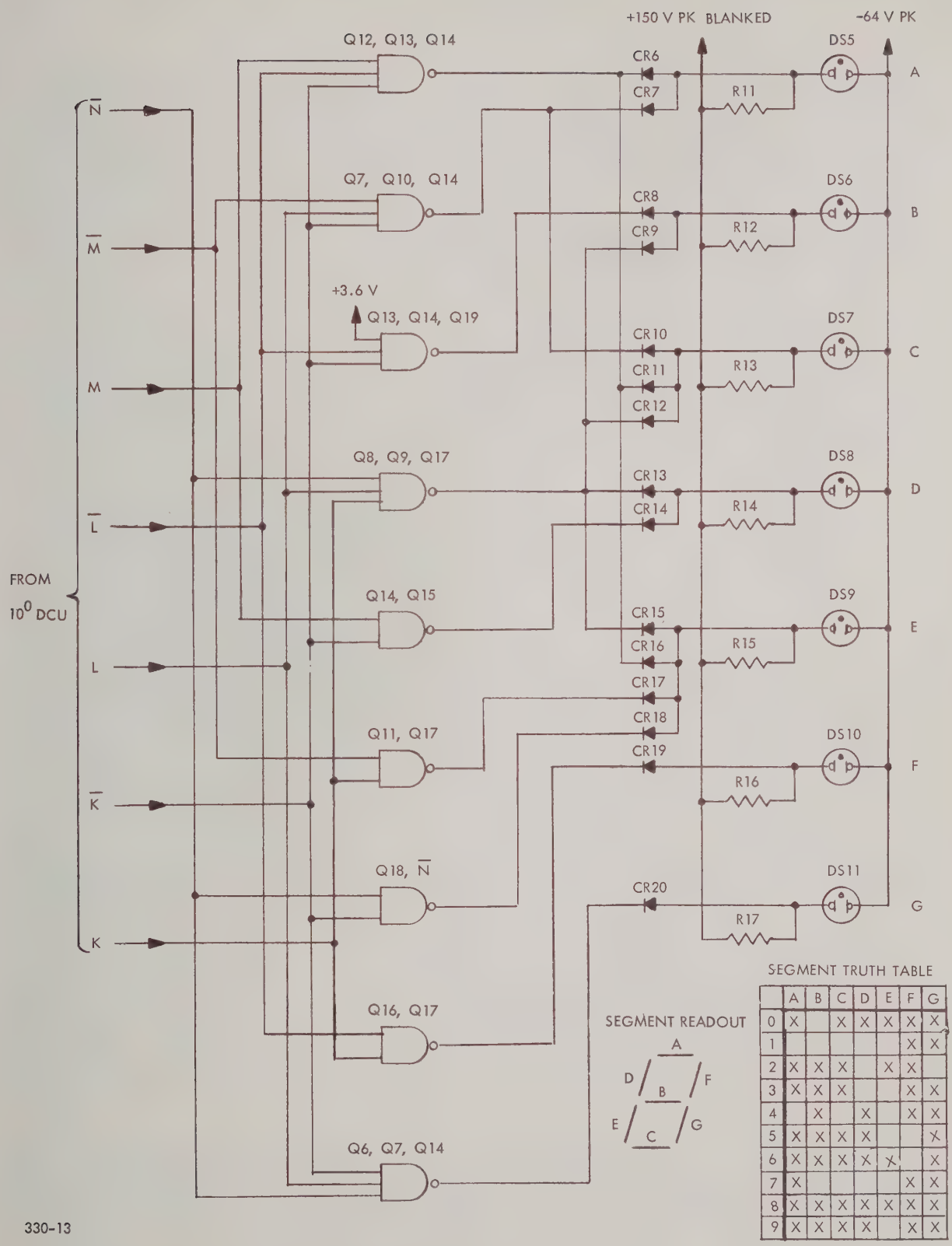
3-36. DECODING NETWORK AND NEON DISPLAY. (Figure 3-10 and Drawing 660202 .) Each digital display consists of seven neon lamps arranged in the configuration shown in Figure 3-10. Diodes CR6 through CR20 constitute AND gates to the neons. When any AND gate input is low, the left side of the neon is pulled down to near zero volts preventing the neon from firing. When all diode inputs to a given gate are high, the left side of the neon is pulled up toward the +150 volt peak blanked input and causes the neon to glow.

NOTE

The quantity +150V PK BLANKED function is analyzed in the description of the power supply, paragraph 3-29.

3-37. The decoding network for diode CR6 associated with neon segment A includes series transistor NAND gates Q12, Q13, and Q4. Referring to the schematic diagram, Drawing 5007310 in Section 6, diode CR6 is connected to the collector of Q12. When the collector of Q12 is low, diodes CR6, CR11, and CR16 pull down the appropriate neon to which they are connected and prevent these neons from firing. Therefore, each set of diodes represents an inhibit on one or more neons when the cathode of a diode is low or near zero volts. The only way that the collector of Q12 can be low is when the bases of Q12, Q13 and Q14 are high and these three transistors are conducting. Thus, this configuration constitutes a NAND function. Transistors Q12, Q13 and Q14 must all be conducting in order for the collector of Q12 to be low. In this event, neon segments A, C and E are inhibited. When the base of either Q12, Q13 or Q14 is low, the NAND gate is inhibited and the collector of Q12 is left floating. If the NAND gates connected to diodes CR7 and/or CR10 and CR12, and/or CR15, CR17, CR18 and CR19 are inhibited, the corresponding segment A, C and/or E is caused to glow.

3-38. The bases and, in some cases, the emitters of transistors in these series NAND gates are connected to control lines from the decimal counting units. Various combinations of the states of these flip flops result in various sets of diodes CR6 through CR20 being grounded and hence various sets of neons are extinguished. The truth table shown on Figure 3-10 shows which segments are illuminated for each decimal number.



	A	B	C	D	E	F	G
0	X		X	X	X	X	X
1						X	X
2	X	X	X		X	X	
3	X	X	X			X	X
4		X		X		X	X
5	X	X	X	X			X
6	X	X	X	X	X		X
7	X					X	X
8	X	X	X	X	X	X	X
9	X	X	X	X		X	X

Figure 3-10. Decoding Logic For Decimal 10^0

3-39. As an example of the logic concept, the illumination of digit 1, segments F and G, is described. Segment F requires that the NAND gate consisting of Q16 and Q17 be inhibited. This means that one or the other 10^0 outputs at $\overline{L}$ or K must be low, and inspection of Figure 3-9 shows that K (inverted AF6B-$\overline{K}$) is low at digit 1 so the NAND gate is inhibited and segment F is caused to glow. Similarly, segment G requires that NAND gate Q6, Q7 and Q14 be inhibited. Therefore, one or more DCU outputs $\overline{N}$, $\overline{L}$ or $\overline{K}$ must be low. Inspection of Figure 3-9 shows that L (inverted AF6A-$\overline{L}$) is low for digit 1, the NAND gate is inhibited, and segment G is also caused to glow to provide the complete digit 1. A similar analysis may be made for segments comprising any other digit.

3-40. CIRCUIT ANALYSIS, ANALOG SECTION

3-41. INTRODUCTION. The analog section of the multimeter consists of two major parts: the signal conditioning part and the voltage to pulse width converter or time ratio digital voltmeter part. Because of the complexity of these circuits, no partial schematic diagrams are included in this section and it is therefore necessary to refer to the complete schematic diagram, Drawing 660202 , in Section 6.

3-42. RANGE AND FUNCTION SWITCHING. Due to the switching complexity, the switches at the extreme left hand side of Drawing 660202 are not analyzed in great detail. Instead, it is assumed that the switching functions are adequate to interconnect the circuit elements in the simplified signal conditioning circuits at the extreme right hand side of the drawing and in Figure 3-4. These circuit elements are described here in great detail.

3-43. The string of resistors that are used for the various measurement functions add up to 10 megohms. The string is used as the voltage divider for the AC and DC measurement functions and portions are used to provide the standard resistors for the current and resistance measurement functions. The resistor string is composed of R2, R3, R4, and variable resistor R5 which is adjusted to provide a total resistance of precisely 9 megohms. The next element in the string is R6 and R7 which is adjusted to equal 900 kilohms. Resistors R8 and R9 similarly equal 90 kilohms, R10 and R11 equal 9 kilohms, and R12, the 1 kilohm precision resistor, completes the 10 megohm string. When used as an AC divider, compensating capacitors C7, C4, C8, C5, C9 and C6 insure flat frequency response. In addition, capacitors C3 and C40 are needed to compensate for the presence or absence of the input amplifier on that mode in the AC function, thereby insuring flat frequency response. These capacitive elements are not included in the DD330 (no AC option). When used as a 10:1 voltage divider, the junction of R5 and R6 is connected to the input amplifier AA1 and the voltage is applied to the top of divider R2. The bottom of R12 is grounded so that the divider string has 9 megohms above the tap and 1 megohm below the tap to form a 10:1 division ratio. Similarly, other taps on the divider provide division ratios of 100:1 and 1000:1. The 10, 000:1 tap is not used in the voltage measurement function. However, the 1000 ohm resistor is used in the resistance measuring mode and in the current measuring mode. When a 1000 ohm precision resistor is required in the current or resistance measuring modes, R12 is used. When 10, 000 ohms is required, the series combination of R12, R11 and R10 is used. For 100K, R12, R10, R9 and R8 are used. The other ranges are provided for in a similar manner.

3-44. SIGNAL CONDITIONING AMPLIFIER. The next element in the measurement chain is the signal conditioning amplifier AA1. This amplifier is used as an AC-to-DC converter in the A-C mode, as a gain of 10 buffer amplifier in the D-C mode, as an operational amplifier in the kilohms mode, and as a current controlled voltage source in the current measurement mode.

3-45. In operation, R15, R16, C10 and C11 provide a current limiting network with frequency compensation. Diodes CR4, CR6, CR3 and CR5 provide a voltage limiting network used to protect the input of the amplifier. Resistors R18 and R19 are isolation resistors going

to the gates of matched field effect transistors Q5 and Q3, respectively. Diodes CR7 and CR9 prevent reverse current from flowing in the FETs. The bias network and sources of these FETs, R28, R29, R33, R34 and R35, permit zero adjustment and compensation for the offset voltage in the source of the FETs. Resistor R34 is the front panel ZERO control which is adjusted in the DC, KILOHMS and current measurement modes. These two transistors provide a differential source follower, the output of which is applied to input pins 5 and 4 on the integrated circuit operational amplifier AA1. Capacitors C14 and C15 in conjunction with resistor R41 insure amplifier stability. Zener diode CR13 and resistor R49 provide the +15 volt shunt regulator while R38 and CR8 comprise the -15 volt regulator. These two supplies power the input section of the amplifier. Resistors R42 and R45 and diodes CR18 and CR35 are an output bias network with temperature compensation used to drive dual complementary collector loaded stage Q10 and Q11. The collectors of Q10 and Q11 connect to the bases of Q17 and Q14, respectively, which are also complementary collector loaded stages. Feedback networks composed of R66, R64, C22, C20, R63 and R58 provide gain stabilization and frequency compensation. The loop stability is insured by rolloff networks made up of R65, C21, R62 and C19 and output rolloff capacitor C23. This amplifier has a gain of approximately two and supplies the high output currents required from this signal conditioning amplifier in order to perform certain functions. Diodes CR28 and CR27 are protection networks on the amplifier output. Resistors R73 and R72 stabilize the gain and provide higher input impedance for transistors Q17 and Q14, respectively. Resistors R53 and R54 are the collector load resistors for Q10 and Q11, respectively.

3-46. The A-C converter circuit connected to the output of this amplifier (DM330 only) includes R80 and C24 which provide simultaneous A-C and D-C feedback. In operation, the A-C voltage appears at the junction of diodes CR30 and CR32, the output rectifier diodes. The negative half cycles reverse bias CR32 but go through CR30 to the voltage division and summing network consisting of R83 and R87 and are fed back to the summing junction through C24. Similarly, positive half cycles are applied through CR32 and R86 to summing resistor R87 and are fed back to the summing junction through C24. Both positive and negative half cycles take different paths back to the feedback network. The positive half cycle is filtered by the network consisting of R88, C29, C32, C33, C34, R90, R92, C31, C36, C37, C38 and C39. This network provides a two-pole passive filter to remove A-C components from the ac converter output.

3-47. Variable resistor R92 is used to adjust the output voltage of the A-C converter for calibration purposes. Resistors R94, R95 and R96 provide the 10:1 feedback divider used in the D-C function to set the gain of the input amplifier to precisely 10.

3-48. INTEGRATING AMPLIFIER. The integrating amplifier is composed of protection network R69, CR25, CR26, dual source followers Q19 and Q18, which feed bias networks R74, R75, R76, R79 and R78. Compensation capacitor C42 insures amplifier stability. The outputs of these source followers feed integrated circuit operational amplifier AA2 at input pins 4 and 5. Resistor R82 and capacitor C25 in conjunction with C27 and C26 insure amplifier stability. Integrating capacitor C28 goes back to the summing junction from the amplifier output.

3-49. In operation, there are four signals which must be switched into the integrating amplifier: the input signal which is switched during time T1, the plus reference or minus reference voltages which are switched during T2, and the shunt across the integrator and zero crossing amplifier which is switched in during time interval T3 to prevent drift. The input voltage coming through resistors R20, R24, and R32, the calibration network, is converted to a proportional current and applied to FET switch Q7. This switch is conductive during time interval T1 by switch transistor Q8 in conjunction with R46, R50 and R55 by $\overline{\text{APPLY SCALED INPUT}}$ from the digital circuits. In addition, the gate from Q8 is also taken to bias resistor R56 through R59 in the base circuit of Q12. Transistor Q12, in conjunction with R51 and

R47, controls the gating of shunt FET switch Q6 and this switch is closed during time intervals T2 and T3. Thus, the input resistance seen on the input end of R20 is constant. If Q7 is conducting, the summing junction being at a virtual ground provides the input impedance. Or, if Q7 is not conducting, Q6 is conducting and provides a constant impedance during times T2 and T3. The input impedance thus remains constant for the full cycle and this is important when used with the AC-to-DC converter.

3-50. The two reference voltages are switched during time interval T2 by diode switches. For example, the positive reference current flows into the junction of CR20 and CR19. If CR20 is reverse biased, the reference current flows into the summing junction through CR19. If, however, the voltage on the cathode end of CR20 is negative, as controlled by switch transistor Q9 from APPLY POSITIVE REF VOLTAGE signal from the digital circuits, the current flows through CR20 and CR19 is reverse biased. Similarly, the negative reference current is switched by CR23 and CR24 and is controlled by switch transistor Q13 from APPLY NEGATIVE REF VOLTAGE from the digital circuits. Bias networks consisting of R57, R60, R61, CR21, CR22, CR17, CR15, CR16, C17, C18 and R52 provide the correct bias levels required to operate the switches.

3-51. The integrator and zero crossing amplifier shunting function provided by FET switch transistor Q15 is controlled by switch transistor Q15 and its associated network. This transistor is in turn controlled by the APPLY FEEDBACK signal from the digital circuits.

3-52. ZERO CROSSING AMPLIFIER. The zero crossing amplifier is composed of protection network R89 and CR33 in the base of collector loaded stage Q20. Collector load resistor R91 operates in conjunction with C30 to shape the frequency response of the amplifier, and the collector of Q20 goes through isolation resistor R93 to limiting diode CR34 and the base of differential amplifier Q21 and Q22. The differential pair provides complementary push pull outputs on the collectors going out to pins 6 and 9. Resistor R97 and R100 are collector load resistors. Resistors R101 and R102 are the base bias network for Q21, while R98 and R99 are the emitter bias network for the complete pair.

3-53. REFERENCE VOLTAGE GENERATION. Reference voltage generation begins with R13 which is matched to Zener diode CR1 and provides a stable reference voltage to the bias string consisting of resistors R14 and R17. These resistors in turn supply temperature compensation diode CR2 and its bias resistor R21 to the voltage-to-current conversion resistors R23, R27 and R31. Following this line further, it is found to be labeled + REF CURRENT. This positive reference is then applied to the operational amplifier for which R22 is the input resistor and R30 is the feedback resistor. The summing junction is at the base of Q1, one of differential pair Q1 and Q2, a matched pair. Resistor R26 is the emitter bias resistor. The collector output of Q1 feeds load resistor R25, frequency compensating capacitor C12, which goes to the base of Q4 through isolation resistor R106. The emitter of emitter follower Q4 then becomes the output of this amplifier, and is fed back as previously described through resistor R30 to the summing junction. Diodes CR10 and CR11 are protection networks against voltage overloads when in the resistance measuring mode. The output of this amplifier is a negative precision voltage which is applied through temperature compensation diode CR14 and resistor R39, through the switching network. This line then comes back around from the switching network in all functions except AC to resistor R43 which is the negative current scaling resistor. This resistor feeds the diode switch composed of CR23 and CR24 to provide control of the negative reference current into the summing junction of the integrator. Fuse F1 is a protection device used in the kilohms function to protect against the application of voltage in the resistance measurement mode. The divider composed of R37 and R36 provides the somewhat smaller amplitude negative reference voltage required in the A-C measurement mode. Temperature compensation diode CR12 operates in conjunction with R40 to compensate for the temperature coefficient of the diode switch used in the negative reference. Capacitor C13 prevents noise pickup on this negative reference line which runs through the input switches.

SECTION 4

MAINTENANCE

4-1. GENERAL

4-2. This section presents maintenance procedures to be followed in order that peak performance of the multimeter can be preserved. Also included are calibration procedures which should be performed periodically and when it is suspected that peak performance is not being obtained from the multimeter. These calibration steps should be carried out whenever repairs are made to the multimeter.

4-3. MAINTENANCE

4-4. No preventive maintenance is required except for occasional cleaning with a soft, dry cloth or soft-bristled brush. Care should be exercised so as not to damage parts on circuit boards.

4-5. TROUBLESHOOTING

4-6. Troubleshooting Chart. Table 4-1 is a step-by-step troubleshooting procedure based on actual visible malfunctions of the multimeter during operation. As can be seen, the table is divided into three columns: Indication, Probable Cause, and Remedy. With an instrument as sophisticated as the multimeter, it is not practical to list all possible causes for malfunction. However, by referencing back to the theory of operation in Section 3 and forward to the assembly and schematic diagrams in Section 6, it should be possible to locate a defective circuit card using a VTVM and an oscilloscope. Alternately, and this procedure is recommended, the multimeter should be returned to the factory for repair and recalibration.

4-7. Test Points. There are no test points on the multimeter circuit boards; however, critical points for the observation of waveforms may be located by inspection of the circuit card assembly drawings 5003709, 5003712 and schematic diagrams 660201 and 660202 in Section 6. Connections between the two circuit cards and between the circuit cards and power transformer with the signal titles and characteristics are shown in Figure 4-1.

4-8. Ground System. In order to provide high common mode rejection and full flexibility, the DM330 includes three separate and mutually insulated commons. These are earth ground, input low and guard. It is important to note, when making measurements, that the reference point used is the one associated with the section under test. Input low and GUARD are available at the front panel terminals.

4-9. REPAIR

4-10. It is not recommended that repairs be attempted unless absolutely necessary. When repairs cannot be accomplished easily, return the entire multimeter to the factory for repair and calibration and include a description of the defect indication and any repairs attempted.

Table 4-1.

Troubleshooting Chart

Indication	Probable Cause	Remedy
No neon indicators light when POWER switch is in ON or TEST position.	Power supply defective.	Check for +150V peak at digital board pins W-11. Check for -64V peak at digital board pins V-11. Troubleshoot power supply circuits.
	Defective fuse.	Replace fuse on rear panel.
	+150V PK FULL WAVE BLANKED not gated.	Troubleshoot gating circuit on digital board.
One neon in display does not light.	Defective neon lamp.	Replace neon lamp.
One neon in display remains lighted continuously.	Defective diode(s) in neon gating circuit.	Replace all diodes associated with neon.
One or more neons in display remain lighted.	Defective transistor in display selection logic.	Replace defective transistor(s).
	Defective inverter in a DCU output.	Replace inverter integrated circuit.
Display counts to same number and no higher.	Defective flip flop in one DCU.	Note displayed value, troubleshoot affected flip flop in DCU.
Display remains all zeros during measurement.	Rate generator or subsequent logic defective.	Observe START pulse on digital board AB3A-3. Troubleshoot rate circuit and subsequent logic.
	Clock generator or subsequent logic defective.	Observe CLOCK pulse at digital board pin 13. Troubleshoot clock circuit and subsequent logic.
Unsatisfactory performance on one or more selected range or function.	Defective timing logic or analog circuit.	Check for presence of signals shown on Figure 4-1 between digital and analog circuit boards (see Figures in Section 3). Troubleshoot suspected circuits on both boards.

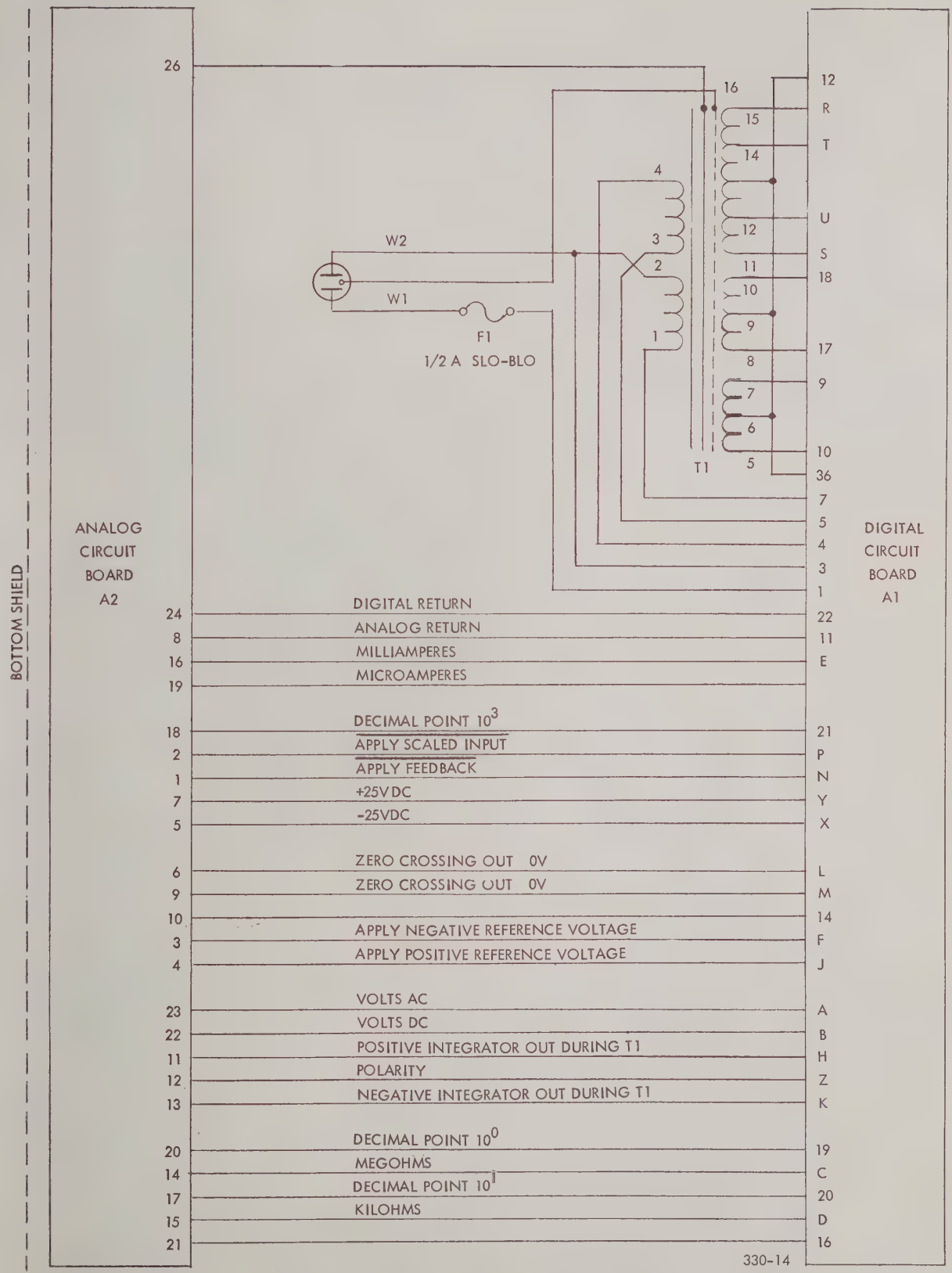


Figure 4-1. Internal Interconnect Diagram

NOTE

It should be noted on the schematic diagram of the Analog Circuit Card A2 in Section 6 of this manual that matched sets of parts are used in some instances. This fact should be observed if parts replacement is attempted.

4-11. DISASSEMBLY

4-12. Access. (Refer to Diagrams in Section 6.) To remove the chassis from the case, remove four No. 6 x 3/8 slotted pan-head self-tapping screws (two on each side) located on the sides near the rear of the cabinet. Slide chassis rearward and away from the case.

4-13. Circuit Cards. To gain access to the component sides of the two circuit cards, place chassis upsidedown and facing forward. Remove two No. 6-32 x 3/16 pan-head screws and No. 6 split lock washers that secure the Analog Circuit Board A2 to the display housing. Raise circuit board upward on the hinge at the rear panel. Further disassembly is not recommended.

CAUTION

Raise analog circuit board A2 slowly and carefully so that harness does not catch on the tall glass trimmer capacitor C7 on this board (Figure 4-2).

4-14. REASSEMBLY

CAUTION

When closing the analog circuit board A2, the harness shall be run over the AC shield plate, around the far side of the sleeved screw with respect to the tall glass trimmer capacitor C7 and behind the 1 microfarad capacitor C8 on the digital circuit board A1 (Figure 4-2). Failure to observe this precaution will upset the AC calibration of the multimeter.

4-15. Reassembly is the reverse of disassembly.

4-16. CALIBRATION

4-17. The following calibration procedure should be performed periodically and after repair or when degradation from peak performance is suspected or observed. Unless otherwise indicated, the black and GUARD terminals should be electrically connected throughout the calibration procedure.

A. Using a Variac® rated at 15 watts or more, connect the multimeter to a 115 VAC outlet and allow a warmup period.

B. Place the multimeter in the TEST mode and note that all neon displays light.

C. Operate RATE control and note that the FAST, SLOW and HOLD positions present a normal display.

D. Remove chassis from case (refer to paragraph 4-12), locate terminals on Digital Circuit Card A1 and, using a VTVM, adjust variable resistors noted below for the indicated voltages (Dwg. 5007309) with Variac adjusted for 115 VAC input to multimeter (Figure 4-3).

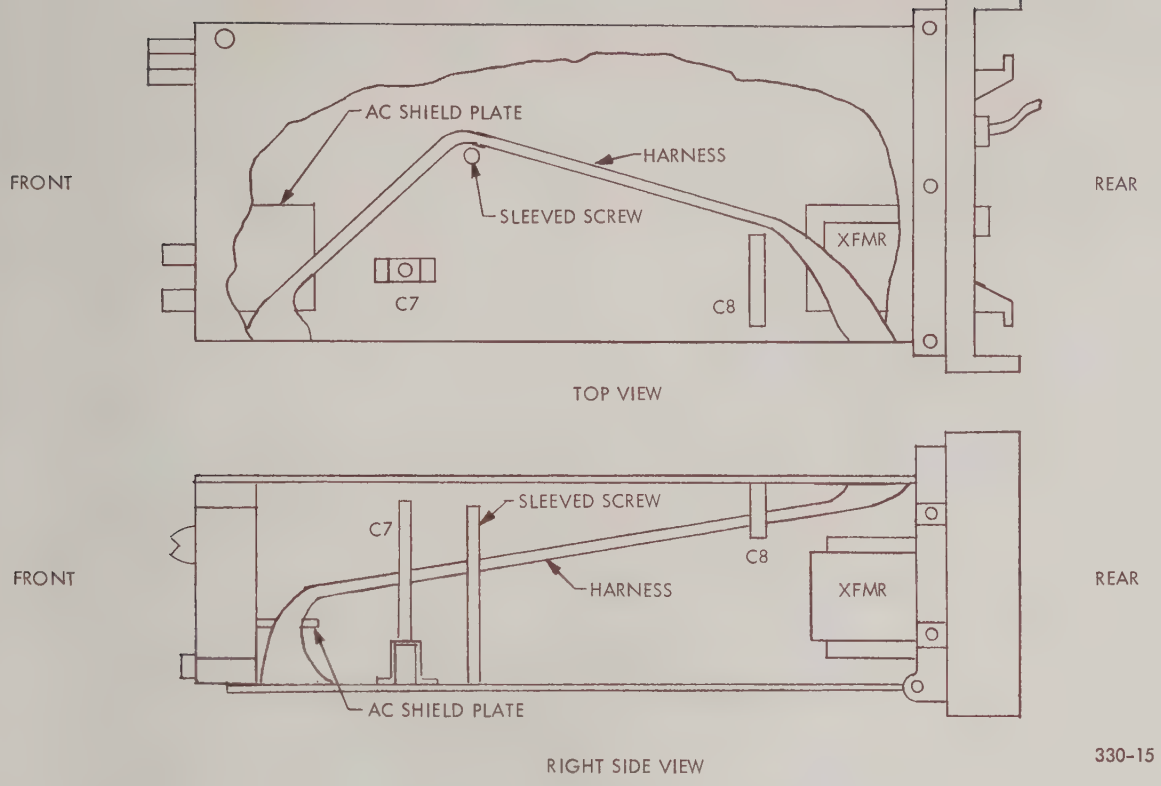


Figure 4-2. Harness Routing

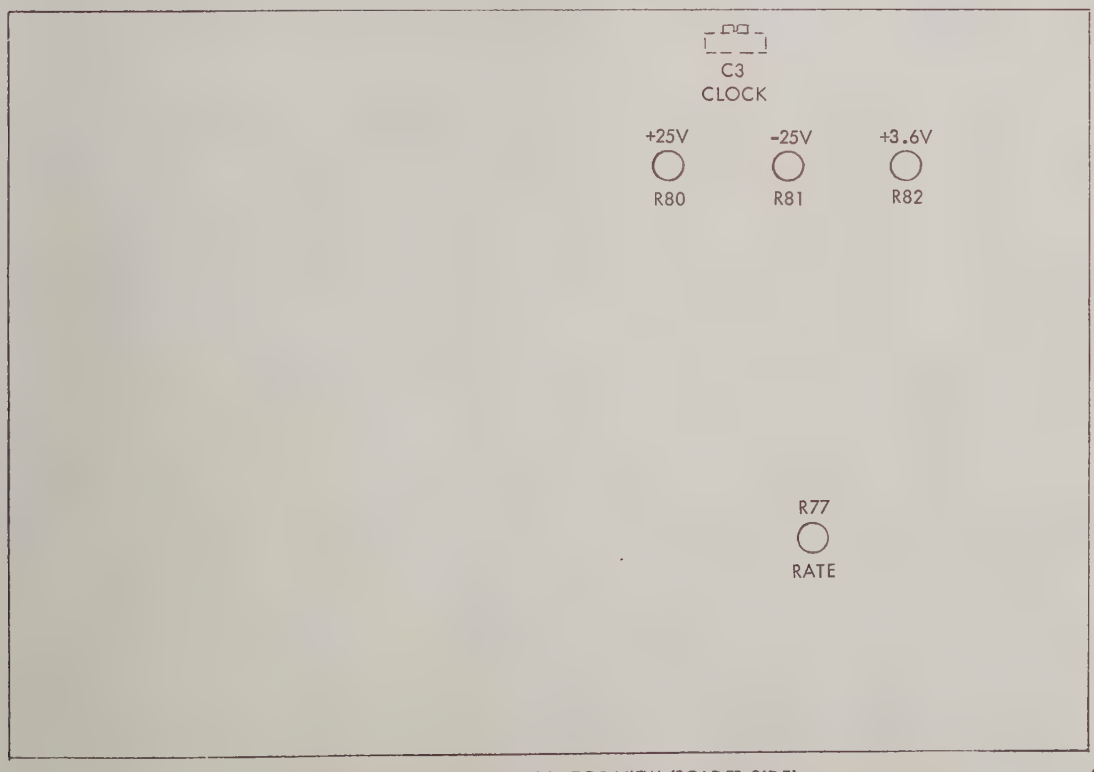


Figure 4-3. Internal Adjustments (sheet 1 of 2)

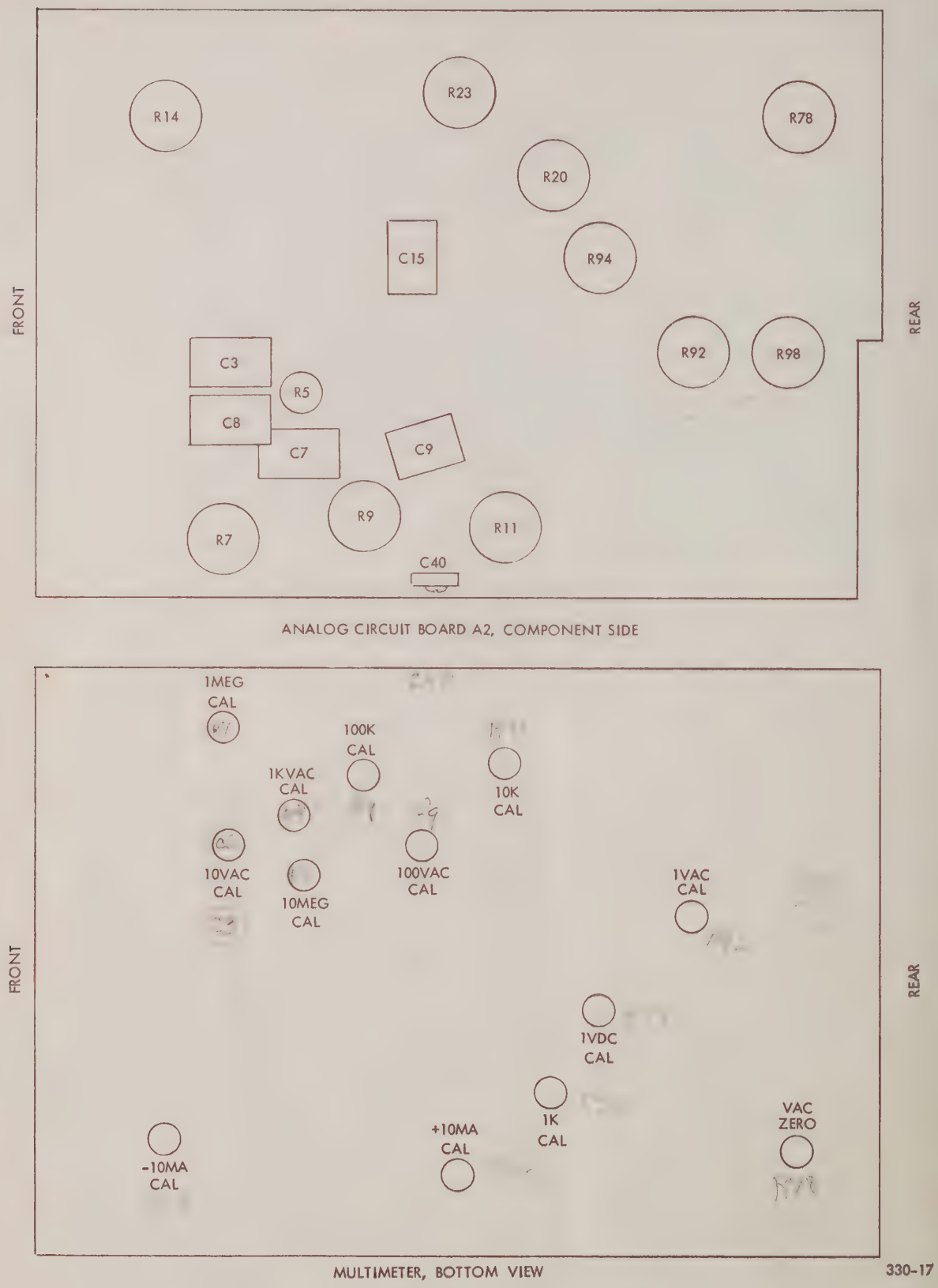


Figure 4-3. Internal Adjustments (sheet 2 of 2)

Terminal	Variable Resistor (Figure 4-1)	Voltage
Y	R80	+25 VDC
X	R81	-25 VDC
14	R82	+3.6 VDC

E. Connect a digital counter or frequency meter to terminal 13 of Digital Circuit Card A1, terminal 13. Adjust C3 for a frequency of 60 KHz ±6 Hz.

F. With RATE control set to FAST, connect oscilloscope Y-input to the collector of Q58 and adjust R77 for a waveform repetition time of 100 ms.

G. Place multimeter back in its case before proceeding to the following steps.

H. Short all input terminals. Press OHMS and 1K pushbuttons and adjust R78, the INTEGRATOR ZERO, until the - sign display flickers.

I. Press VDC pushbutton and adjust front panel ZERO screwdriver adjustment for flicker of - sign display. Repeat steps H and I until no further adjustment is required.

J. Select OHMS function and 1K range and connect 1.0005 ±0.0001K ohms across red and black terminals. Adjust 1K CAL R20 for flicker of the display between 1.000 and 1.001.

K. Select 10K range and connect 10.0005 ±0.001 K ohms across red and black terminals. Adjust 10K CAL R11 for flicker of display between 10.00 and 10.01.

L. Select 100K range and connect 100.05 ±0.01 K ohms across red and black terminals. Adjust 100K CAL R9 for flicker of display between 100.0 and 100.1.

M. Select 1 MEG range and connect 1.0005 ±0.0001 megohms across red and black input terminals. Adjust 1 MEG CAL R7 for flicker of display between 1.000 and 1.001.

N. Select 10 MEG range and connect 10.005 ±0.001 megohms across red and black terminals. Adjust 10 MEG CAL R5 for flicker of display between 10.00 and 10.01.

O. Press AMPS DC function and 10 MA range pushbuttons. Apply a current of 10.005 ±0.001 MA to the red (+) and black (-) terminals. Adjust -10 MA CAL R14 for flicker between 10.00 and 10.01 and - sign of display.

P. Apply a current of +10.005 ±0.001 MA to the red (+) and black (-) terminals. Adjust +10 MA CAL R23 for flicker between 10.00 and 10.01 and + sign display.

Q. Apply a short circuit to all input terminals and push VDC function and 1V range pushbuttons. Note that display indication is 0.000. If not, adjust front panel zero.

R. Apply 1.0005 ±0.0001 volts DC to the red (+) and black (-) terminals. Adjust 1 VDC CAL R94 for a flicker of between 1.000 and 1.001 with a + display.

NOTE

Steps S through X apply to Model DM330 only.

S. With all input terminals shorted, select AC function and 10V range. Adjust INTEGRATOR ZERO R78 for 0.000 with flicker on - sign display.

T. Select 1V range and apply 1.0005 ±0.001 volts AC at 1000 ± 1 Hz to the input terminals. Adjust 1 VAC CAL R94 for a flicker between 1.000 and 1.001.

U. Apply 1.000 ±0.001 volts AC to the input terminals. Verify ±5 digits when the input frequency is 100, 1000, and 10000 Hz.

V. Select 1 KV range and apply 1.0005 ±0.001 KV AC at 10 KHz to input terminals. Adjust 1K VAC CAL C7 so as to correct for one-half total error.

W. Select 10V range and apply 10.005 ±0.01 VAC at 10 KHz to input terminals. Adjust 10V VAC CAL C8 for flicker between 10.00 and 10.01.

X. Select 100V range and apply 100.05 ±0.1 VAC at 10 KHz to input terminals. Adjust 100 VAC CAL C9 for flicker between 100.0 and 100.1.

Y. Repeat steps V through X until ±1 digit accuracy is obtained on all three ranges without further adjustment.

SECTION 5

PARTS LIST

5-1. GENERAL

5-2. This section provides the information necessary to procure replacements for all of the electrical parts in the multimeter. The list covers both the Model DM330 (with AC Option) and the Model DD330 (without AC Option). The area of difference is the Analog Circuit Board, wherein the QTY column first digit or single digit reflects the quantity used for Part No. 5007312-1 (DM330), while the second number, if present, is the quantity for Part No. 5007312-2 (DD330).

PARTS LIST

REF DES	PART NO.	DESCRIPTION 1 2 3 4	QTY	CODE
	5007296	DM330 Multimeter, Main Assy	Ref	06692
A1	5007309	. DIGITAL CIRCUIT BOARD ASSY (see breakdown below)	1	06692
A2	5007312 (-1 & -2)	. ANALOG CIRCUIT BOARD ASSY (see breakdown below)	1	06692
F1	313.500	. FUSE, 1/2A, Slo-blo	1	75915
T1	3-17314-1	. TRANSFORMER	1	06692
F2	AGX1/32A	. FUSE, FAST ACTING, 1/32A, 250V	1	71400
W1	C-2103-076GY	. POWER CORD WITH PLUG 3 COND. 6 FT GREY NO. 18	1	80126
W2	4007763	. HARNESS, CABLE	1	06692
A1	5007309	DIGITAL CIRCUIT BOARD ASSY	Ref	06692
AB3, 7, 13, 20	MC899P	. INTEGRATED CIRCUIT, DUAL BUFFER	4	04713
AF4, 6, 8 10, 12, 14, 17	SC-2292P	. INTEGRATED CIRCUIT, DUAL J-K FLIP FLOP	7	04713
AG2, 9, 16, 18, 19	MC-824P	. INTEGRATED CIRCUIT, QUAD 2-INPUT GATE	5	04713
A11, 5, 11, 15	MC889P	. INTEGRATED CIRCUIT, HEX INVERTER	4	04713
C1	TYPE BG	. CAPACITOR, CERAMIC, 0.01 µf ± 20%, 500V	1	77638
C2	220P6PS-D20	. CAPACITOR, POLYESTER, 0.002 µf ± 10%, 600V	1	05571
C3	467	. CAPACITOR, MICA, VARIABLE 110-580 PF	1	04062
C4	225P47391	. CAPACITOR, POLYESTER, 0.047 µf ± 10%, 100V	1	05571
C5	TYPE BG	. CAPACITOR, CERAMIC DISC, 470 pf ± 20%, 500V	1	77638
C6	TYPE BG	. CAPACITOR, CERAMIC DISC, 0.003 µf ± 20%, 500V	1	77638
C7	PVC1168	. CAPACITOR, MYLAR, 0.068 µf ± 10%, 100 WVDC	1	04713
C8	165A105K	. CAPACITOR, MYLAR, 1 µf ± 10%, 50 VDC	1	83125
C9, 10	TYPE 984	. CAPACITOR, ELECTROLYTIC, 500 µf, 30V	1	83125

PARTS LIST (Continued)

REF DES	PART NO.	DESCRIPTION 1 2 3 4	QTY	CODE
C11	977-246	. CAPACITOR, ELECTROLYTIC, 10,000 µf, 6V	1	83125
C12	TYPE BG	. CAPACITOR, DISC CERAMIC, 0.001 µf ± 20%, 500V	1	77638
C13	5HKS50	. CAPACITOR, POLYESTER, .05 uf ± 10%, 500 V	1	05571
CR1	1N4148	. DIODE, SILICON	1	09214
CR2 THRU CR64 EXCEPT CR21, 38, 55 NOT USED	1007545	. DIODE, SILICON	60	06692
CR65, 66 67, 68	1N4820	. DIODE, SILICON	4	93539
CR69, 70 71, 72	1N4818	. DIODE, SILICON	4	93539
CR73, 74	1N4816	. DIODE, SILICON	2	93539
DS1 THRU DS35	C2A	. LAMP, NEON GLOW, NE2H	35	24446
DS36	5AB	. LAMP, NEON GLOW, NE-23	1	24446
L1	2500-52	. INDUCTOR, 3.3 Mh	1	99800
Q1, 7, 9 13, 14, 17, 22, 24, 28 29, 32, 37 39, 43, 44, 47	2N5134	. TRANSISTOR, SILICON, NPN	16	07263
Q2, 58	2N5133	. TRANSISTOR, SILICON, NPN	2	07263
Q3, 4, 5 6, 8, 10, 11 12, 15, 18, 19	1007599	. TRANSISTOR, SILICON, NPN	40	06692

PARTS LIST (Continued)

REF DES	PART NO.	DESCRIPTION 1 2 3 4	QTY	CODE
20, 21, 23, 25, 26, 27, 30, 31, 33, 34, 35, 36, 38, 40, 41, 42, 45, 46, 48 THRU 57				
Q59, Q60	40327	. TRANSISTOR, SILICON, NPN	2	95445
S1	RS38, STYLE B KNOB BLACK	. SWITCH, ROCKER, MBB, 2P3T, W LG FLAT BRKT	1	78488
S2	RS42, STYLE B KNOB RED	. SWITCH, ROCKER, MBB, 2P3T, SPRING RTN 3T02, W LG FLAT BRKT	1	78488
R1, 75	RC20GF681K	. RESISTOR, CARBON COMP, 680 Ω ± 10%, 1/2W	2	MIL-R-11
R2, 3	RC20GF103K	. RESISTOR, CARBON COMP, 10K ± 10%, 1/2 W	2	MIL-R-11
R4	RC20GF223K	. RESISTOR, CARBON COMP, 22K ± 10%, 1/2W	1	MIL-R-11
R5, 7, 9, 10, 12 THRU 18, 25, 27 THRU 33, 42, 44 THRU 50, 58, 60 THRU 65, 72,	RC20GF473K	. RESISTOR, CARBON COMP, 47K ± 10%, 1/2W	35	MIL-R-11
R6, 8, 11, 19 THRU 24, 26, 34 THRU 40, 43, 51 THRU 57, 59, 66 THRU 71, 73, 83	RC20GF471K	. RESISTOR, CARBON COMP, 470 Ω ± 10%, 1/2W	34	MIL-R-11
R41, 84	RC20GF102K	. RESISTOR, CARBON COMP, 1K ± 10%, 1/2W	2	MIL-R-11
R74, 76	RC20GF562K	. RESISTOR, CARBON COMP, 5.6K ± 10%, 1/2W	2	MIL-R-11
R77	MTC-4	. RESISTOR, VARIABLE, CARBON FILM 3.5 MEGO ±20%, 1/4W, 500V	1	04713

PARTS LIST (Continued)

REF DES	PART NO.	DESCRIPTION 1 2 3 4	QTY	CODE
R78	RC20GF471K	. RESISTOR, CARBON COMP, 470K ± 10%, 1/2W	1	MIL-R-11
R79	RC42GF272K	. RESISTOR, CARBON COMP, 2.7K ± 10%, 2W	1	MIL-R-11
R80, 81	TYPE 115	. RESISTOR, VARIABLE, INSULATED, 50 Ω ± 20%, 2W, 3 TERM.	1	71450
R82	TYPE 115	. RESISTOR, VARIABLE, INSULATED, 1 Ω ± 20%, 2W, 3TERM.	1	71450
A2	5007312-1	ANALOG CIRCUIT CARD ASSY (AC OPTION)	Ref	06692
	5007312-2	ANALOG CIRCUIT CARD ASSY (NO AC OPTION)	Ref	06692
		NOTE The first number in the QTY column is -1, second number is -2		
AA1, 2	1007865	. I.C. AMPLIFIER	2/2	06692
C1	GPD	. CAPACITOR, DISC CERAMIC, 0.05 µf -0 + 100%, 1000 WVDC	1	00656
C2, 35	CPR22J	. CAPACITOR, POLYSTYRENE, 22 pf ± 5%, 500 WVDS	2	71590
C3, 8, 40	461	. CAPACITOR, TRIMMER, MICA, 2.7-30pf, 175 WVDC	3	04062
C4	CPR91J	. CAPACITOR, POLYSTYRENE, 91 pf ± 5%, 500 WVDC	1	71590
C5	CPR910J	. CAPACITOR, POLYSTYRENE, 910 pf ± 5%, 500 WVDC	1	71590
C6	CPR10, 000J	. CAPACITOR, POLYSTYRENE, 10, 000 pf ± 5% 500 WVDC	1	71590
C7	VC-28G	. CAPACITOR, TRIMMER, PISTON, 0.8-30 pf, 5000 WVDC	1	73899
C9	464	. CAPACITOR, TRIMMER, MICA, 25-280 pf, 175 WVDC	1	04062
C10, 11	TYPE B	. CAPACITOR, DISC CERAMIC, 0.01 µf, GMV, 1000 WVDC	2/2	77638
C12, 17, 18 42	TYPE BG	. CAPACITOR, DISC CERAMIC, 0.01 µf ± 20%, 500 WVDC	4/4	77638

PARTS LIST (Continued)

REF DES	PART NO.	DESCRIPTION 1 2 3 4	QTY	CODE
C13, 14	225P10491	. CAPACITOR, POLYESTER, 0.1 µf ± 10%, 100 WVDC	2/2	05571
C15	463	. CAPACITOR, TRIMMER, MICA, 9-180 pf, 175 WVDC	1/1	04062
C16	225P10391	. CAPACITOR, POLYESTER, 0.01 µf ± 10%, 100 WVDC	1/1	05571
C19, 21	TYPE BG	. CAPACITOR, DISC CERAMIC, 120 pf ± 20%, 500 WVDC	2/2	77638
C20, 22, 23	TYPE BG	. CAPACITOR, DISC CERAMIC, 470 pf ± 20%, 500 WVDC	3/3	77638
C24, 25, 29, 31 THRU 34, 36, 37, 38, 39	165A105K	. CAPACITOR, MYLAR 1 uf ± 10%, 50 WVDC	11/1	76433
C26	TYPE CG	. CAPACITOR, DISC CERAMIC, 47 pf ± 20%, 500 WVDC, TCN-220	1/1	77638
C27	TYPE CG	. CAPACITOR, DISC CERAMIC, 10 pf ± 20%, 500 WVDC, TCN-220	1/1	77638
C28	225P47391	. CAPACITOR, POLYESTER, 0.047 pf ± 10%, 100 WVDC	1/1	05571
C30	TYPE BG	. CAPACITOR, DISC CERAMIC, 0.001 pf ± 20%, 500 WVDC	1/1	77638
CR1	1007803-1	. DIODE, SILICON	1/1	06692
CR2, 12, 14, 19, 20, 23, 24	1007411	. DIODE, SILICON	7/7	06692
CR3 THRU CR6, 25,26	1007546-1	. DIODE, SILICON	6/6	06692
CR7, 9, 10, 11, 17, 18, 27, 28, 30, 32, 33, 34	1N4148	. DIODE, SILICON	12/10	09214

PARTS LIST (Continued)

REF DES	PART NO.	DESCRIPTION 1 2 3 4	QTY	CODE
CR8, 13, 29, 31	1N965A	. DIODE, ZENER	4/4	81483
CR15, 16, 21, 22	1007546-2	. DIODE	4/4	06692
CR35	1N270	. DIODE	1/1	07263
J1	DF21RC	. BINDING POST, RED	1/1	58474
J2	DF21BC	. BINDING POST, BLACK	1/1	58474
J3	DF21WC	. BINDING POST, WHITE	1/1	58474
Q1, Q2	2007770-1	. TRANSISTOR, SILICON, PNP, Q1 AND Q2 MATCHED PAIR	2/2	06692
Q3, Q5	1007737-1	. TRANSISTOR, SILICON, FET, Q3 AND Q5 MATCHED PAIR	2/2	06692
Q4	2N5142	. TRANSISTOR, SILICON, PNP	1/1	07263
Q6, 7, 15	1007737-3	. FET, SILICON, N-CHANNEL	3/3	06692
Q8, 9, 12, 13, 16	2N5139	. TRANSISTOR, SILICON, PNP	5/5	07263
Q10	2N5135	. TRANSISTOR, SILICON, NPN	1/1	07263
Q11, 20	2N5138	. TRANSISTOR, SILICON, PNP	2/2	07263
Q14	40412	. TRANSISTOR, SILICON, NPN	1/1	86684
Q17	2N4888	. TRANSISTOR, SILICON, PNP	1/1	07263
Q18, 19	1007737-1 or -2	. FET, SILICON, N-CHANNEL, Q18 AND Q19 MATCHED PAIR	2/2	06692
Q21, 22	2N5133	. TRANSISTOR, SILICON, NPN	2/2	07263
R1	RC20GF101K	. RESISTOR, CARBON COMP, 1000 Ω 10%, 1/2W	1/1	MIL-R-11
R2	1-17308	. RESISTOR, METAL FILM, 8.82 MEGO ± 1%,	1/1	06692
R3, 4	NOT USED			

PARTS LIST (Continued)

REF DES	PART NO.	DESCRIPTION 1 2 3 4	QTY	CODE
R5	371-5	. RESISTOR, VARIABLE, MOLDED CARBON, 500K ± 20%	1/1	12697
R6	SAM-2	. RESISTOR, METAL FILM, 896K, ± 0.1%, + 40-10 PPM/°C	1/1	12126
R7, 20, 23, 34, 78, 92	TYPE 115 BG88417	. RESISTOR, VARIABLE, WIRE WOUND, 10K ± 20%, 2W INSULATED, 3 TERM	6/5	71450
R8	SAM-2	. RESISTOR, METAL FILM, 88.7K ± 1%, + 40-10 PPM/°C	1/1	12126
R9	TYPE 115 BA74587	. RESISTOR, VARIABLE, WIRE WOUND, 5K ± 20%, 2W INSULATED, 3 TERM	1/1	71450
R10	SAM-2	. RESISTOR, METAL FILM, 8.87K ± 1% +40-10 PPM/°C	1/1	12126
R11, 98	TYPE 115 BA74589	. RESISTOR, VARIABLE, WIRE WOUND, 500 Ω ± 20%, 2W INSULATED, 3 TERM	2/2	71450
R12	SAM-2	. RESISTOR, METAL FILM, 1000 Ω ± 0.1% + 40-10 PPM/°C	1/1	12126
R13	1007803-1	. RESISTOR, METAL FILM, MATCHED IN MFR TO CR1	1/1	06692
R14	TYPE 115 BG88416	. RESISTOR, VARIABLE, WIRE WOUND, 50Ω ± 20%, 2W INSULATED, 3 TERM	1/1	71450
R15, 16	RC32GF105K	. RESISTOR, CARBON COMP, 1 MEGO ± 10%, 1W	2/2	MIL-R-11
R17	2007234	. RESISTOR, METAL FILM, SELECTED IN TEST	1/1	06692
R18, 19, 47, 53, 54, 59, 61, 67, 103	RC20GF103K	. RESISTOR, CARBON COMP, 10K ±10%, 1/2W	9/9	MIL-R-11
R21	RC20GF224K	. RESISTOR, CARBON COMP, 220K ± 10%, 1/2W	1/1	MIL-R-11
R22	SAM-2	. RESISTOR, METAL FILM, 2.37K ± 1%, +40-10 PPM/°C	1/1	12126
R24	SAM-2	. RESISTOR, METAL FILM, 464K ± 1%, +40-10 PPM/°C	1/1	12126
R25, 105	SAM-2	. RESISTOR, METAL FILM 4.42K ± 1%, +40-10 PPM/°C	2/2	12126
R26	SAM-2	. RESISTOR, METAL FILM, 7.15K ± 1%, +40-10 PPM/°C	1/1	12126

PARTS LIST (Continued)

REF DES	PART NO.	DESCRIPTION 1 2 3 4	QTY	CODE
R27	2007234	. RESISTOR, METAL FILM, SELECTED AT TEST	1/1	06692
R28	SAM-2	. RESISTOR, METAL FILM, 75 Ω 1%, +40-10 PPM/°C	1/1	12126
R29, 35, 75, 79	SAM-2	. RESISTOR, METAL FILM, 51.1K ± 1%, +40-10PPM/°C	4/4	12126
R30	SAM-2	. RESISTOR, METAL FILM, 4.99K ± 1%, +40-10 PPM/°C	1/1	12126
R31	SAM-2	. RESISTOR, METAL FILM, 215K ± 1%, +40-10 PPM/°C	1/1	12126
R32	2007234	. RESISTOR, METAL FILM, SELECTED AT TEST	1/1	06692
R33	SAM-2	. RESISTOR, METAL FILM, 154 Ω ± 1%, + 40-10 PPM/°C	1/1	12126
R36	SAM-2	. RESISTOR, METAL FILM, 1.40K ± 1%, + 40-10 PPM/°C	1/1	12126
R37	SAM-2	. RESISTOR, METAL FILM, 3.57K ± 1%, +40-10 PPM/°C	1/1	12126
R38, 49	RC32GF104K	. RESISTOR, CARBON COMP, 330 Ω ± 10%, 1W	2/2	MIL-R-11
R39, 81	RC20GF104K	. RESISTOR, CARBON COMP, 100K ± 10%, 1/2W	2/2	MIL-R-11
R40, 80	RC20GF105K	. RESISTOR, CARBON COMP, 1 MEGO ± 10%, 1/2W	2/1	MIL-R-11
R41, 82	RC20GF4R7K	. RESISTOR, CARBON COMP, 4.7 Ω ± 10%, 1/2W	2/2	MIL-R-11
R42, 45	RC20GF912J	. RESISTOR, CARBON COMP, 9.1K ± 5%, 1/2W	2/2	MIL-R-11
R43	SAM-2	. RESISTOR, METAL FILM, 499K ± 1%, +40-10 PPM/°C	1/1	12126
R44	Not Used			
R46, 51	RC20GF273K	. RESISTOR, CARBON COMP, 27K ± 10%, 1/2W	2/2	MIL-R-11
R48	RC20GF681K	. RESISTOR, CARBON COMP, 680 Ω ± 10%, 1/2W	1/1	MIL-R-11
R50, 77	RC20GF223K	. RESISTOR, CARBON COMP, 22K ± 10%, 1/2W	2/2	MIL-R-11
R52, 57	RC20GF562K	. RESISTOR, CARBON COMP, 5.6K ± 10%, 1/2W	2/2	MIL-R-11
R55, 84	RC20GF122K	. RESISTOR, CARBON COMP, 1.2K ± 10%, 1/2W	2/2	MIL-R-11
R56	RC20GF274K	. RESISTOR, CARBON COMP, 270K ± 10%, 1/2W	1/1	MIL-R-11
R58, 66	RC20GF332K	. RESISTOR, CARBON COMP, 3.3K ± 10%, 1/2W	2/2	MIL-R-11

PARTS LIST (Continued)

REF DES	PART NO.	DESCRIPTION 1 2 3 4	QTY	CODE
R60	RC20GF123K	. RESISTOR, CARBON COMP, 12K ± 10%, 1/2W	1/1	MIL-R-11
R62, 65	RC20GF821K	. RESISTOR, CARBON COMP, 820 Ω ± 10%, 1/2W	2/2	MIL-R-11
R63, 64 68,69,93,106	RC20GF221K	. RESISTOR, CARBON COMP, 220 Ω ± 10%, 1/2W	6/6	MIL-R-11
R70	RC32GF221K	. RESISTOR, CARBON COMP, 220 Ω ± 10%, 1W	1/1	MIL-R-11
R71	RC20GF472K	. RESISTOR, CARBON COMP, 4.7K ± 10%, 1/2W	1/1	MIL-R-11
R72, 73	RC20GF271K	. RESISTOR, CARBON COMP, 270 Ω ± 10%, 1/2W	2/2	MIL-R-11
R74	SAM-2	. RESISTOR, METAL FILM, 215 Ω ± 1%, +40-10 PPM/°C	1/1	12126
R76	SAM-2	. RESISTOR, METAL FILM, 442 Ω ± 1%, +40-10PPM/°C	1/1	12126
R83	RC20GF622J	. RESISTOR, CARBON COMP, 6.2K ± 5%, 1/2W	1	MIL-R-11
R85	1007803-1	. RESISTOR, MATCHED IN MFR TO CR1	1/1	06692
R86	SAM-2	. RESISTOR, METAL FILM, 6.34K ± 1%, +40-10 PPM/°C	1	12126
R87	SAM-2	. RESISTOR, METAL FILM, 1K ± 1%, +40-10 PPM/°C	1	12126
R88	SAM-2	. RESISTOR, METAL FILM, 37.4K ± 1%, +40-10 PPM/°C	1	12126
R89	RC20GF222K	. RESISTOR, CARBON COMP, 2.2K ± 10%, 1/2W	1	MIL-R-11
R90	2007234	. RESISTOR, METAL FILM, SELECTED AT TEST	1	06692
R91	RC20GF333K	. RESISTOR, CARBON COMP, 33K ± 10%, 1/2W	1/1	MIL-R-11
R94	TYPE 115 BB86988	. RESISTOR, VARIABLE, WIRE WOUND, 1K ± 20%, 2W INSULATED, 3 TERM	1/1	71450
R95	SAM-2	. RESISTOR, METAL FILM, 11.3K ± 1%, +40-10 PPM/°C	1/1	12126
R96	SAM-2	. RESISTOR, METAL FILM, 1.30K ± 1%, +40-10 PPM/°C	1/1	12126
R97, 100	RC20GF391K	. RESISTOR, CARBON COMP, 390Ω ± 10%, 1/2W	2/2	MIL-R-11
R99	SAM-2	. RESISTOR, METAL FILM, 887 Ω ± 1%, +40-10 PPM/°C	1/1	12126
R101	RC20GF182K	. RESISTOR, CARBON COMP, 1.8K ± 10%, 1/2W	1/1	MIL-R-11
R102	RC20GF331K	. RESISTOR, CARBON COMP, 330Ω ± 10%, 1/2W	1/1	MIL-R-11

PARTS LIST (Continued)

REF DES	PART NO.	DESCRIPTION 1 2 3 4	QTY	CODE
R104	SAM-2	. RESISTOR, METAL FILM, 1.78K ± 1%, +40-10 PPM/°C	1/1	12126
R107	RC20GF753K	. RESISTOR, CARBON COMP, 75K ± 10%, 1/2W	1/1	MIL-R-11
R108	RC20GF105K	. RESISTOR, CARBON COMP, 10 MEGO ± 10%, 1/2W	1/1	MIL-R-11
S1	3007738-1	. SWITCH GROUP, PUSHBUTTON	1/1	06692
S2	3007739-1	. SWITCH GROUP, PUSHBUTTON	1/1	06692

SECTION 6

DIAGRAMS

6-1. GENERAL

6-2. This section contains the schematic and interconnecting diagrams for the circuit cards and chassis assemblies of the Model DM330 multimeter. Also included is the top assembly drawing as an aid in the performance of the disassembly and reassembly procedures in Section 4. The drawings included are listed in drawing number numerical order as follows:

5007296	Top Assembly, DM330 Multimeter
660200	Schematic, DM330 Assembly
5007309	Assembly, Digital Board A1
660201	Schematic, Digital Board Assembly A1
5007312	Assembly, Analog Board A2
660202	Schematic, Analog Board Assembly A2

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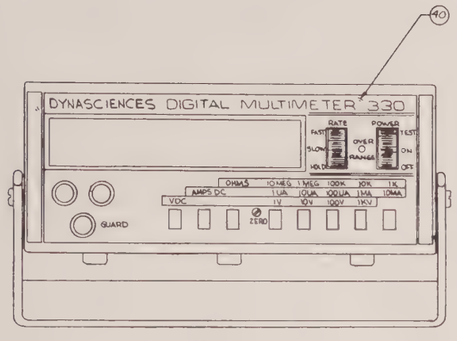
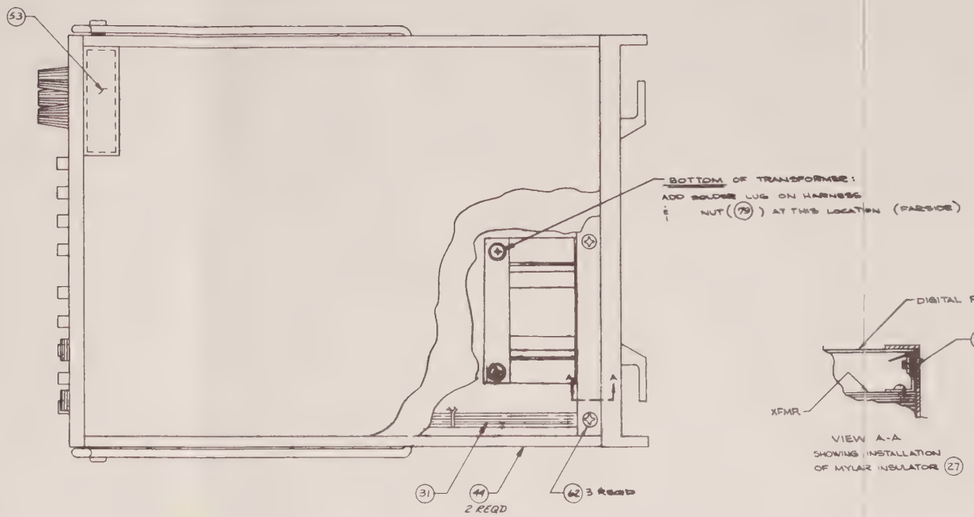
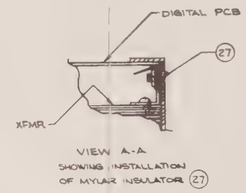
ECO NO	ECN REV	P/C REV	ASSY REV	REVISIONS DESCRIPTION	DATE	APPROVAL
			A	PRODUCTION RELEASE	4/1965	R. T. [illegible] 6/1965
			B	REVISED PER ECO 6021	8-1965	[illegible] 9/1/65
			C	REVISED PER ECO 6107 & 6285	8-1966	[illegible] 11/1966
			D	REVISED PER ECO 6292	11-1966	[illegible] 12/1966
			E	REVISED PER ECO 6427	1-1967	[illegible] 1-1967
F-1	F	F	F	REVISED PER ECO 6460	2-1967	[illegible] 2/1967
	G	G	G	SEE DCN	9-1968	[illegible] 9/1968

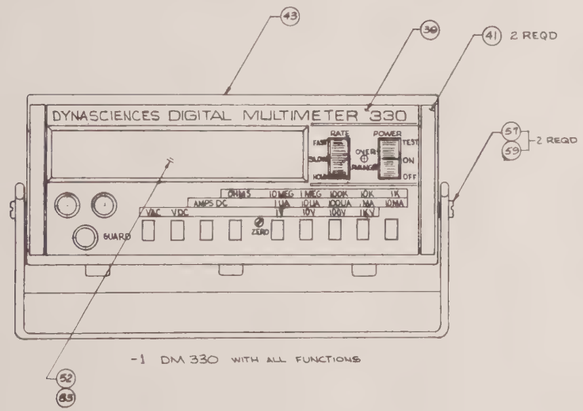


-2 DD 330 WITHOUT AC

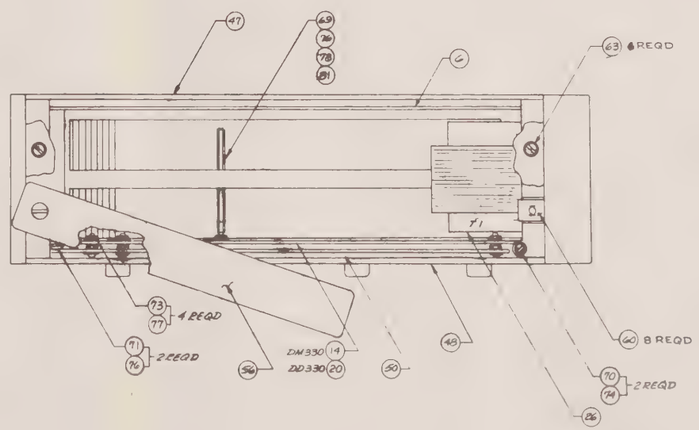


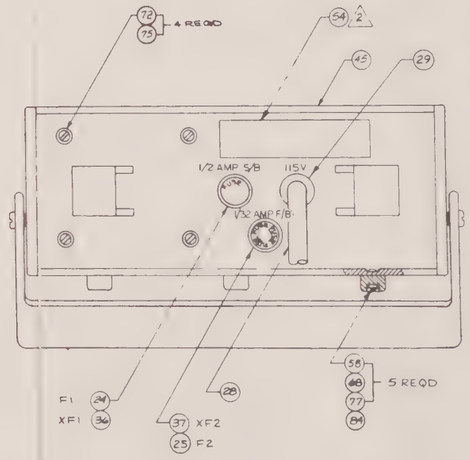


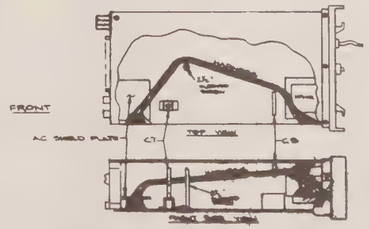
VIEW A-A
SHOWING INSTALLATION
OF MYLAR INSULATOR (27)



-1 DM 330 WITH ALL FUNCTIONS







VIEWS SHOWING HARNESS ROUTING (2)

BOX ASSEMBLY INSTRUCTIONS

1. INSTALL WINDOW (ITEM 52) INTO FRONT PANEL (ITEM 43) USING ADHESIVE (ITEM 85)
2. INSTALL SPEED NUTS (ITEM 60) INTO FRONT PANEL (ITEM 43), 4 PLACES.
3. MOUNTED FRONT PANEL (ITEM 43), SIDE PANELS (ITEM 44) & REAR PANEL (ITEMS 47 & 48); ALIGNING THREE PARTS SO THAT THEY ARE FLUSH & HOLDING IN PLACE BY MEANS OF SCREWS SHOWN.
4. USING INSTALL STRIP, SECURE, BLUE STRIP, PANEL, SIDE PANELS & REAR EXTERNAL CABLE TOGETHER. USE ONE [illegible] OF [illegible] SHOWN.

(1) WHEN CLOSING UNIT: HARNESS TO BE OVER AC SHIELD PLATE, BEHIND TALL GLASS TRIMMER CAPACITOR (C7) & 2½" 4-40 SLEEVED SCREW ON ANALOG BOARD, AND BEHIND 1 MFD CAPACITOR (C8) ON DIGITAL BD. AC CALIBRATION WILL BE AFFECTED UNLESS HARNESS IS ROUTED AS PER DETAIL.

WHEN OPENING UNIT: CAUTION: OPEN UNIT SLOWLY, SO THAT HARNESS DOES NOT CATCH ON TALL GLASS TRIMMER CAPACITOR (C7) ON ANALOG BOARD

(2) MARK IDENTIFICATION DATA IN APPROPRIATE SPACES WHERE SHOWN.

1. REF DWG: SCHEMATIC - 660200
   PARTS LIST - PL 5007296

NOTES: UNLESS OTHERWISE SPECIFIED

DASH NO.	BASIC	ZONE	PART NUMBER	CODE IDENT	DESCRIPTION	REFERENCE DESIGNATOR	ITEM NO.
			5007296-2		MULTIMETER ASSY	DD330	2
			5007296-1		MULTIMETER ASSY	DM330	1
REQD PER ASSY					PARTS LIST		

UNLESS OTHERWISE SPECIFIED INTPR DWG PER MIL-STD-100
DIM ARE IN INCHES
DO NOT SCALE DRAWING
DIM. TO BE MET AFTER FINISH
STANDARD HOLES PER ANSI B32
SURFACE ROUGHNESS √
CUSTOMER & SPEC.
SIMILAR TO

MATERIAL
HEAT TREAT
FINISH
NEXT ASSY | USED ON DM 330

CONTRACT NO
DRAWN BY: R.P.G. DATE: 8.7.69
CHECKER H.K. 9-11-69
DESIGNER
MECH APPR
ELEC APPR [illegible] 9/16/69
APPROVED

DYNASCIENCES CORPORATION — INSTRUMENT SYSTEMS DIVISION of Whittaker Corporation — CHATSWORTH CALIFORNIA

TITLE: 3 DIGIT MULTIMETER ASSY

SIZE	CODE IDENT NO	DWG NO.
E	06692	5007296

SCALE 1/1 WT SHEET 1 OF 1

DWG NO. 5007296 REV G

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B. WITHOUT THE WRITTEN CONSENT OF INSTRUMENT SYSTEMS DIVISION OF DYNASCIENCES CORPORATION THIS DRAWING IN WHOLE OR IN PART, AND THE INFORMATION CONTAINED HEREIN UNDER NO CIRCUMSTANCES WILL BE USED IN THE MANUFACTURE OR REPRODUCTION OF THE ARTICLE SHOWN AND DELIVERY OF THIS DRAWING SHALL NOT CONSTITUTE ANY RIGHT OR LICENSE TO DO SO.
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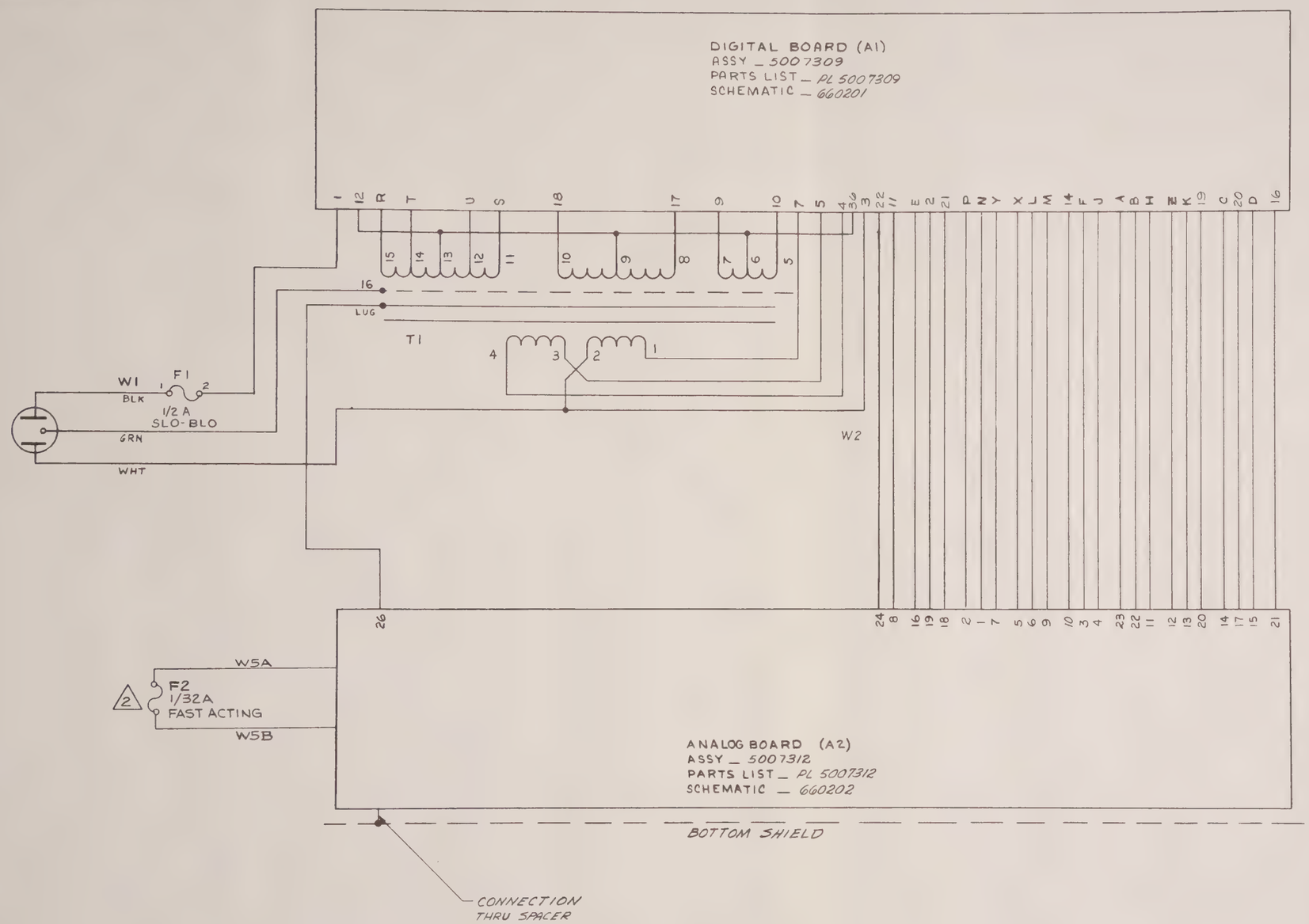
ASSY REV	P/L REV	SCH REV	REVISIONS DESCRIPTION	DATE	APPROVAL
		A	SEE OCN J.I.G.	9-7-67	

DIGITAL BOARD (A1)
ASSY _ 5007309
PARTS LIST _ PL 5007309
SCHEMATIC _ 660201



REF DESIGNATION	
LAST USED	NOT USED
A2	
F2	
T1	
W2	

660200
A

2. SEE ANALOG BOARD ASSY DWG 5007312 FOR EXACT HOOK-UP OF F2.

1. REF DWG PARTS LIST _ PL 5007296
ASSEMBLY _ 5007296

NOTES: UNLESS OTHERWISE SPECIFIED

DASH NO.	BASIC	PART NUMBER	CODE IDENT	DESCRIPTION	REFERENCE DESIGNATOR	ITEM NO
REQD PER ASSY		PARTS LIST				

APPLICATION	NEXT ASSY	USED ON
	DD330	
	DM330	

UNLESS OTHERWISE SPECIFIED INTERPRET DRAWING PER MIL-STD-100
DIMENSIONS ARE IN INCHES
DO NOT SCALE DRAWING
DIMENSIONS TO BE MET AFTER FINISH
STANDARD HOLES PER AND10387
SURFACE ROUGHNESS √
CUSTOMER & SPEC
SIMILAR TO

MATERIAL
HEAT TREAT
FINISH
NEXT ASSY | USED ON

CONTRACT NO.
DRAWN BY J.G. DATE 7-12-67
CHECKER H.K. 9-17-67
DESIGNER
MECH APPR
ELEC APPR 10 ENG 9/3
APPROVED

DYNASCIENCES CORPORATION — INSTRUMENT SYSTEMS DIVISION, A SUBSIDIARY OF Whittaker CORPORATION — CHATSWORTH CALIFORNIA

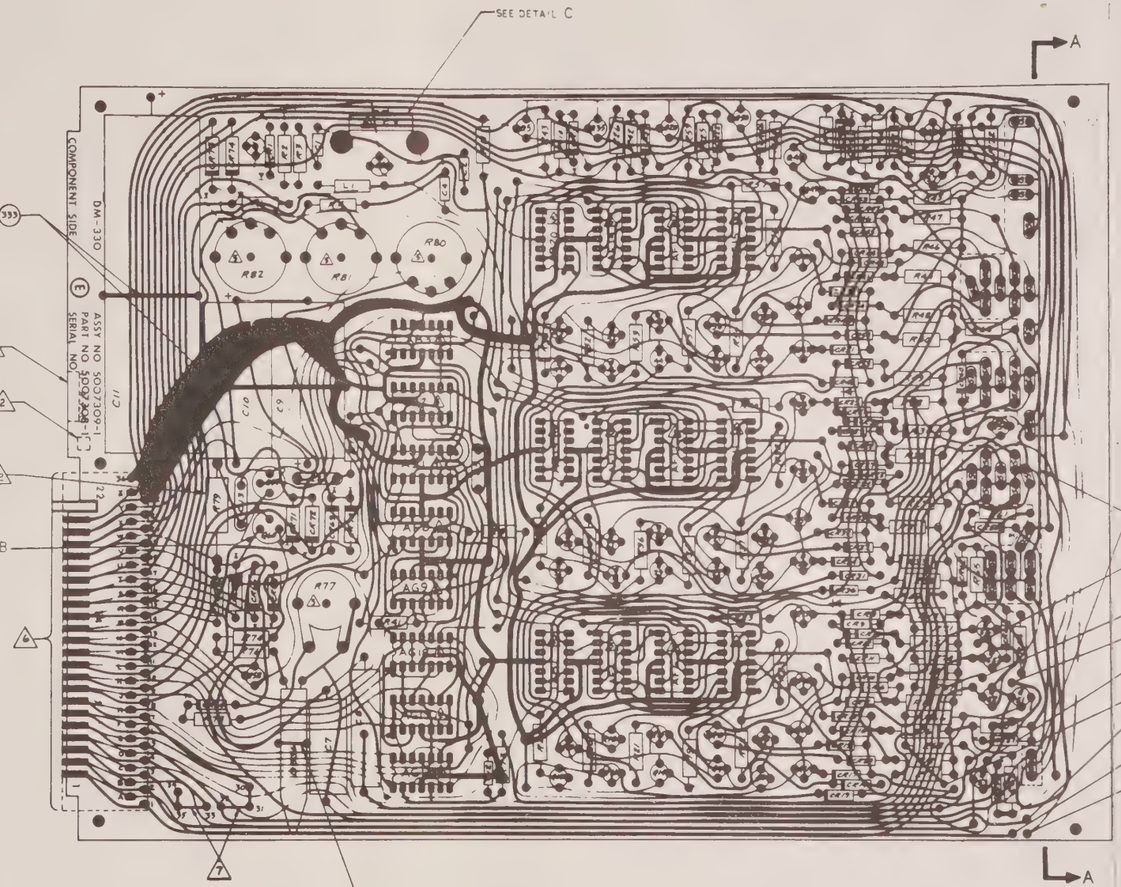
TITLE: SCHEMATIC - MAIN

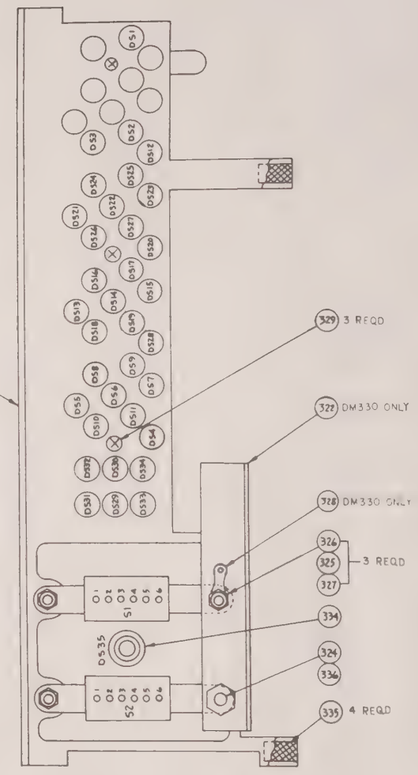
SIZE	CODE IDENT NO.	DWG NO.
D	06692	660200

SCALE NONE | WT | SHEET 1 OF 1

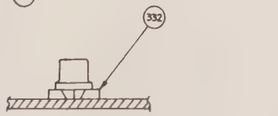
6/67 DIETERICH-POST CLEARPRINT 1000H-8

REVISIONS					
ECO	SCH REV	P/L REV	ASSY REV	DESCRIPTION	DATE / APPROVAL
			A	REVISED PER ECO 6133	9-9-66 DT
			B	REVISED PER ECO 6267	1-19-67 DT
			C	REVISED PER ECO 6433	4/18/67 DT
	G	G	G	REVISED PER ECO 6682	9/14/67 DT
	G	G	H	REVISED PER ECO 6515	9/14/67 DT
			J	REVISED REF DWG NO. 5	3-17-69 ML

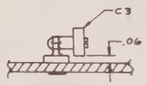




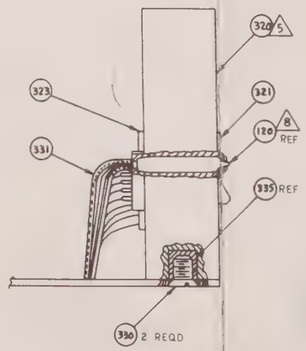
VIEW A-A

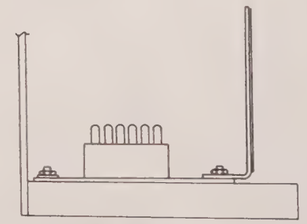


DETAIL B
TYP Q59 & Q60



DETAIL C





△12 R79 TO BE MOUNTED .06 (MIN) ABOVE PCB

△11 DISPLAY HOUSING TO BE INSTALLED AFTER FLOW SOLDERING

10. CONNECTIONS ON SOLDER SIDE OF PCB TO PROTRUDE NO MORE THAN .06

9. TRANSISTORS WITHOUT TRANSIPADS TO BE MOUNTED .06 (MIN) ABOVE PCB

△8 OVERRANGE BULB (ITEM 120) TO BE INSERTED INTO RECESS UNTIL IT BOTTOMS (TIP SHOULD STICK OUT FROM CONE IN FRONT OF DISPLAY HOUSING)

△7 JUMPERS SHOWN CONNECTED FOR 115VAC OPERATION - FOR 230VAC OPERATION REMOVE (2) JUMPERS SHOWN AND CONNECT (1) JUMPER BETWEEN 31 & 33

△6 MASK DOTTED AREAS (-----) WHEN FLOW SOLDERING BOARD

△5 DO NOT IMMERSION CLEAN (26) ITEMS INDICATED

4. MAX PROJECTION FROM SOLDER SIDE TO BE .06

△3 PERMANENTLY MARK DATE CODE WHERE SHOWN

△2 PERMANENTLY MARK REVISION LETTER OF THIS DWG WHERE SHOWN

1. REF DWG: SCHEMATIC 660201
PARTS LIST PL 5007309

NOTES: UNLESS OTHERWISE SPECIFIED

ITEM NO	QTY REQD	PART NUMBER	DESCRIPTION	REF DES	MATERIAL OR VENDOR	FINISH OR VENDORS ADDRESS
1	1	5007309-1	DIGITAL PCB ASSY		DARCY	

LIST OF MATERIALS

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
THIRD ANGLE PROJECTION
REMOVE ALL BURRS AND SHARP EDGES
TOLERANCES
X ±.1 XX ±.02 XXX ±.010 ANGLES -0 30'
DO NOT SCALE DRAWING
MATERIAL
FINISH

DRAWN [signature] DATE 5/6/68
CHECKED [signature] DATE 5-16-68
DESIGN ENGR DATE
APPROVED FOR RELEASE [signature] DATE 5/16/68
APPROVED [signature] DATE 5/16/68

MASTER CONTROL CORPORATION — CHATSWORTH CALIFORNIA

TITLE PCB ASSEMBLY-DIGITAL

MODEL DM330, DD330

SIZE E | CODE IDENT 29011 | DWG NO 5007309 | REV J

SCALE 2:1 | SHEET 1 OF 1

NOTES: UNLESS OTHERWISE SPECIFIED

6. ALL CAPACITORS ARE IN MICROFARADS
7. EITHER 115VAC OR 230 VAC JUMPERS ARE USED - NOT BOTH.
6. ALL DIODES ARE 1007545
5. ALL TRANSISTORS ARE 1007599
4. ALL LAMPS ARE CEA (NE-2H)
3. ALL RESISTORS ARE 1/2 W ±10% IN Ω.
2. ALL IC's TO HAVE 3.6V REF SUPPLIED TO PIN 4
1. ALL IC's TO HAVE +3.6V SUPPLIED TO PIN NO. 14

9. REF DWG: ASSY 5007509 P/L PL 5007509

DASH NO	BASIC PART NUMBER	CODE IDENT	DESCRIPTION	REFERENCE DESIGNATOR	ITEM NO
REQD PER ASSY			PARTS LIST		

DYNASCIENCES CORPORATION — CHATSWORTH CALIFORNIA

TITLE: SCHEMATIC DIAGRAM DIGITAL (A1)

SIZE D | CODE IDENT NO 06692 | DWG NO 660201

SCALE NONE | WT | SHEET 1 OF 1

660201

EDO	SCH REV	P/L REV	SYM	REVISIONS DESCRIPTION	DATE	APPROVAL
			A	PRODUCTION RELEASE	9/4/68	DT
			B	REVISED PER ECO 6080	9/24/68	DT
B-1			C	REVISED PER ECO 6297	1/7/69	DT
			D	REVISED PER ECO 6334	1/29/69	DT
D-1 D-2			E	REVISED PER ECO 6426	3/4/69	DT
F-1			F	REVISED PER ECO 6437	3/3/69	DT
			H	REVISED PER ECO 6365	4/21/69	DT
			J	REVISED PER ECO 6455	5/6/69	DT
	N	N	N	REVISED PER ECO 6481	5/8/69	DT
	N	N	P	REVISED PER ECO 6499	5/15/69	DT
H-1	R	R	R	REVISED PER ECO 6574	8/28/69	DT
	S	S	S	SEE DCN		

DETAIL D

CUT 9 PLCS

LATCHBAR SPRING LOCATION

DETAIL E

CUT 6 PLCS

LATCHBAR SPRING LOCATION

DETAIL F

3/16 MIN

R5

RTV AROUND EDGES OF R5

DETAIL G

C40

.06

DETAIL H

C32 C29 C33 C34

249

DETAIL J

C36 C38 C31 C37

263 17

245

10

TYP 3 PLACES

CUT INDICATED PINS AS CLOSE TO BODY AS POSSIBLE (WITHOUT ENTERING INTO SQUEEZED AREA) NEAR SIDE ONLY (.075) MAX

DETAIL K 18 ALTERNATE

C38 C36 C37 C31 C39 C25 C29 C32 C33 C34 C24

SEE DETAIL K

PAD 25

241 245

258 3 REQD (NUTS FURNISHED WITH BINDING POST)

J1 RED

J3 WHT

J2 BLK

9

DO NOT INSTALL C1 WITH LEADS UPRIGHT, LEADS FROM C1 FAR SIDE (TOWARD REAR OF UNIT)

7 51 225

BEFORE INSTALLATION OF SWITCH- MODIFY PER DETAIL E

245

INSTALL POT SHAFT 233 & BRACKET 234 PRIOR TO INSTALLING SWITCHES

THESE BUTTONS TO BE RED

BEFORE INSTALLATION OF SWITCH- MODIFY PER DETAIL D

241 245

THIS WIRE TO BE LOOPED BACK AS SHOWN TO PREVENT CONTACT WITH DISPLAY HOUSING ON DIGITAL BOARD

J2 BLK

S2 7 226

LATCH SPRING (TYP)

S1A S1B S2A S2B S3A S3B

WIPER

R2

DETAIL F

DM-330 ASSY NO 5007312-1 PART NO 5007311-1 SERIAL NO. COMPONENT SIDE

SEE DETAIL J SEE DETAIL H SEE DETAIL K

SEE DETAIL G

2 REQ'D 229 242 244 246 236

2 REQ'D 242 244 246

236 242 244 246 2 REQ'D

257 259 260 2 REQ'D

SECTION A-A

2 REQ'D 243 247

230 2 REQ'D (REF)

232 231 2 REQ'D (RUF)

SECTION B-B

234 233 235 257

SPOT TIE W2C TO CAPACITOR

.125 MAX

239 242 246

240 242 246 2 REQ'D

242 2 REQ'D

SHIELDED JUMPER DETAIL

SCALE 1:1

W5B W1 W5A W4 SPOT TIE

W2A CONNECT TO TOP OF RESISTOR MTG TERMINAL

W2C CONNECTED TO TOP OF CAPACITOR

W3 W2B

230 231 2 REQ'D (REF)

VIEW C-C

.075 5

CATHODE

WITHOUT AC

	DO NOT INSTALL FOR DD330
C	C1 TO C9, C24, C29, C31 TO C40
CR	CR30, CR32
R	R80, 83, 86, 87, 88, 92, 90
W	W1, W2C

241 245	JUMPER LIST FROM	TO
	J2	S1A-8
	S1A-1	S1B-8
	J3	PAD 25

18 DETAIL K IS TOP VIEW SHOWING ALTERNATE INSTALLATION OF CAPACITORS. SEE SHT 3A OF P/L FOR ALTERNATE PART NUMBERS

17 TAPE C36 TO C31 AND C38 TO C37 PER ITEM 263 BEFORE INSTALLING

16 DELETED

15 BOTTOM OF Q20, Q21 & Q22 TO BE .050 MAX ABOVE PCB

14 R34 TO BE FLUSH WITH PCB

13 SPACER & SOLDER LUG NEEDED AT R5 FOR DD330

12. CONNECTIONS ON SOLDER SIDE OF PCB TO PROTRUDE NO MORE THAN .06

11. TRANSISTORS TO BE MOUNTED .06 MIN ABOVE PCB

10 INSTALL 1/2" OF 1/4" VINYL SLEEVING THAT HAS BEEN DILATED IN LAQUER THINNER FOR 2 HRS OR MORE

9 REMOVE FRONT BUTTON OF S1A PER 3007738 EDO B1 FOR DD330

8 RESISTOR VALUE TO BE DETERMINED BY TEST

7 DO NOT IMMERSION CLEAN (29) ITEMS INDICATED - DO NOT LET SOLVENT SPLASH BUTTONS OR CASE OF S1, S2, C4, C5 & C6

6 CONNECT C1 BETWEEN S1A-3 & S1B-9

5 TO INSURE .075 DIM USE SWITCH COMB #3007306-1 BETWEEN SWITCH AND P C BOARD DURING SOLDERING

4. MAX PROJECTION FROM SOLDER SIDE TO BE 0.10

3 PERMANENTLY MARK DATE CODE WHERE SHOWN

2 PERMANENTLY MARK REVISION LETTER OF THIS DWG WHERE SHOWN

1. REF DWG: SCHEMATIC 660202

PARTS LIST PL 5007312

NOTES. UNLESS OTHERWISE SPECIFIED

20 WIRES W5A & W5B TO FUSE (F2) IN REAR PANEL. TO BE CONNECTED DURING TEST.

19. THIS BOARD NOT TO BE WAVE SOLDERED.

2	5007312-2	ASSY ANALOG PCB		DD330	
1	5007312-1	ASSY ANALOG PCB		DM330	
ITEM NO	PART NUMBER	DESCRIPTION	CODE IDENT	MATERIAL OR VENDOR	FINISH OR VENDORS ADDRESS
QTY REQ'D		LIST OF MATERIALS			

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES THIRD ANGLE PROJECTION REMOVE ALL BURRS AND SHARP EDGES TOLERANCES .X ±.1 .XX ±.02 .XXX ±.010 ANGLES 0 30

DO NOT SCALE DRAWING

MATERIAL

FINISH

DRAWN R. Blum DATE 3/17/68

CHECKED D. Kuhl DATE 5-15-69

DESIGN ENGR DATE

APPROVED FOR RELEASE DATE

APPROVED DATE

APPROVED DATE

MASCHINES CORPORATION CHATSWORTH CALIFORNIA

TITLE PCB ASSEMBLY ANALOG MODEL DM330 DD330

SIZE E CODE IDENT 29011 DWG NO 5007312 REV S

SCALE 2:1 SHEET 1 OF

5007312 S

NOTICE: THIS DRAWING IS PART OF THE PROPRIETARY ARTICLE HEREIN DISCLOSED, OWNED BY INSTRUMENT SYSTEMS CORP. (HEREINAFTER REFERRED TO AS "ISC"), A SUBSIDIARY OF WHITTAKER CORPORATION, A CALIFORNIA CORPORATION, AND IS LOANED SUBJECT TO THE AGREEMENT THAT:
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FUNCTION SWITCH POSITIONS S1	RANGE SWITCH POSITIONS S2A	S2B	S2C	S2D	S2E
DC (A)	1V	10V	100V	1000V	—
AC (B)	1V	10V	100V	1000V	—
IDC (C)	10A	100A	1000A	1MA	10MA
RES (D)	10M	1M	100K	10K	1K

SWITCH SHOWN WITH NO BUTTONS DEPRESSED

REVISIONS				
ACSY REV	P/L REV	SCH REV	DESCRIPTION	DATE / APPROVAL
		A	SEE DCN	

J3 GUARD — ANALOG BOARD SHIELD — J4

J1 IN HI — SEE NOTE FOR DD330 — S1A (AC) — VAC (23) — DIG. RET. (24) — C1 .05UF 1000WVDC — S1B (DC) — VDC (22) — POS INTEG OUT DURING TI (11) — POLARITY (12) — NEG INTEG OUT DURING TI (13) — S1C (I)

J2 INPUT LOW — S1D (R) — DEC PT 10⁰ (20) — S2A — MΩ (14) — DEC PT 10¹ (17) — S2B — KΩ (15) — DEC PT 10² (21) — S2C — DEC PT 10³ (18) — S2D — S2E — UA (19) — MA (16)

R1 1K; R2 1-1/7308 8.82 M ±1%; R3 696K ±0.1%; R4 88.7K ±1%; R5 500K 10 MEG CAL; R6 10K; R7 10K 1 MEG CAL; R8 88.7K ±1%; R9 5K 100K CAL; R10 8.87K ±1%; R11 500Ω 1.0 K CAL; R12 1K ±0.1%

C2 22 PF; C3 2.7-30 PF 175 WVDC (10 VAC COMPEN); C4 91 PF ±5%; C5 910 PF ±5%; C6 10,000 PF ±5%; C7 0.8-30 PF 5000 WVDC (1K VAC CAL); C8 2.7-30 PF 175 WVDC (10 VAC CAL); C9 25-280 PF 175 WVDC (100 VAC CAL); C35 22 PF (100 VAC COMPEN); C40 2.7-30 PF 175 WVDC

CR1 1007803-1; CR2 1007411; CR3 1007546-1; CR4 1007546-1; CR5 1007546-1; CR6 1007546-1; CR7; CR8 IN965A 15V; CR9; CR10; CR11; CR12 1007411; CR13 IN965A 15V; CR14 1007411; CR15 1007546-2; CR16 1007546-2; CR17 1007546-2; CR18; CR19 1007411; CR20 1007411; CR21 1007546-2; CR22 1007546-2; CR23 1007411; CR24 1007411; CR25 1007546-1; CR26 1007546-1; CR27; CR28; CR29 IN965A 15V; CR30; CR31 IN965A 15V; CR32; CR33; CR34; CR35 IN270

Q1 2007770-1; Q2 2007770-1; Q3 1007737-1; Q4 2N5142; Q5 1007737-1; Q6 1007737-3; Q7 1007737-3; Q8 2N5139; Q9 2N5139; Q10 2N5135; Q11 2N5138; Q12 2N5139; Q13 2N5139; Q14 RCA 40412; Q15 1007737-3; Q16 2N5139; Q17 2N4888; Q18 1007737-2; Q19 1007737-2; Q20 2N5138; Q21 2N5133; Q22 2N5133

AA1 1007865; AA2 1007865

R13 1007803-1; R14 50Ω; R15 1MEG 1W; R16 1MEG 1W; R17; R18 10K; R19 10K; R20 10K (1K CAL); R21 220K; R22 2.37K ±1%; R23 10K (10MA CAL); R24 464K ±1%; R25 4.42K ±1%; R26 7.15K ±1%; R27; R28 75Ω ±1%; R29 51.1K ±1%; R30 4.99K ±1%; R31 215K ±1%; R32; R33 154Ω ±1%; R34 10K (FRONT PANEL ZERO); R35 51.1K ±1%; R36 1.40K ±1%; R37 3.57K ±1%; R38 330Ω 1W; R39 100K; R40 1M; R41 4.7A; R42 9.1K ±5% ½W; R43 499K ±1%; R44 680Ω; R45 9.1K ±5% ½W; R46 27K; R47 10K; R48 10K; R49 330Ω 1W; R50 22K; R51 27K; R52 5.6K; R53 10K; R54 10K; R55 1.2K; R56 270K; R57 5.6K; R58 3.5K; R59 10K; R60 12K; R61 10K; R62 820Ω; R63 220Ω; R64 220Ω; R65 820Ω; R66 3.5K; R67 10K; R68 220Ω; R69 220Ω; R70 220Ω ±10% 1W; R71 4.7K; R72 150Ω; R73 150Ω; R74 215Ω ±1%; R75 51.1K ±1%; R76 9.42Ω ±1%; R77 22K; R78 10K; R79 51.1K ±1%; R80 1M; R81 100K; R82 4.7Ω; R83 6.25K ±5%; R84 1.2K; R85 1007803-1; R86 6.34K ±1%; R87 1.00K ±1%; R88 37.4K ±1%; R89 2.2K; R90; R91 33K; R92 10K (1 VDC CAL); R93 220Ω; R94 1K (1 VDC CAL); R95 11.3K ±1%; R96 1.3K ±1%; R97 390Ω; R98 500Ω (ZERO XING BAL); R99 887Ω ±1%; R100 390Ω; R101 1.8K; R102 330Ω; R103 10K

C10 .01UF 1KV; C11 .01UF 1KV; C13 0.1UF; C14 0.1UF; C15 9-180PF (FREQ COMPEN); C16 .01UF; C17 .01UF; C18 .01UF; C19 120 PF; C20 470PF; C21 120PF; C22 470PF; C23 470PF; C24 1UF; C25 1UF; C26 47PF; C27 10PF; C28 .0470F ±10%; C29 1UF; C30 .001UF; C31 1UF; C32 1UF; C33 1UF; C34 1UF; C36 1UF; C37 1UF; C38 1UF; C39 1UF; C42 .01UF

F1 1/32A (13); F2 1/32A (13)

+15V; -15V; +25V; -25V; +10MA CAL; -10MA CAL; 1K CAL; 1 VDC CAL; 1 VAC CAL; SUMMING JUNCTION; + REF CURRENT; - REF CURRENT; ZERO XING BAL; FRONT PANEL ZERO; FREQ COMPEN; INTEGRATOR ZERO

"APPLY SCALED INPUT" (2); "APPLY FEEDBACK" (1); +25V (7); -25V (5); ANALOG RET (8); "ZERO-CROSSING OUT > 0V" (6); "ZERO-CROSSING OUT < 0V" (9); +3.6V (10); APPLY NEGATIVE REF VOLTAGE (3); APPLY POSITIVE REF VOLTAGE (4)

AC: EIN 1V → A1 → ≈2.3V TO DVM INTEGRATOR

DC: EIN 1V → A1 → 10V TO DVM INTEGRATOR

KΩ: REF, RSTD, RX → A1 → TO DVM INTEGRATOR; TO DVM REF

CURRENT: IIN, RSTD → A1 → 10V TO DVM INTEGRATOR

SIMPLIFIED SIGNAL CONDITIONING

WITHOUT AC

	■ = NOT INSTALLED FOR DD330
C	C1 TO C9, C31 TO C40, C24, C29
CR	CR30, CR32
R	R83, R86, R117, R88, R90, R92, R80

1. ALL DIODES IN4148 OR IN914
2. R17, R27, R32 & R90 SELECT IN TEST (2007234)
3. ALL POTENTIOMETERS 2W ±20% ROTATION INDICATED IS CW AS SEEN FROM SOLDER SIDE OF BOARD
4. ALL 1% & .1% RESISTORS ARE METAL FILM ±50PPM/°C OR LESS
5. ALL RESISTORS 1/2W ±10% VALUES IN OHMS
6. Q1 & Q2 (2007770-1) MATCHED SET TO BE MOUNTED IN THERMAL CONTACT
7. Q3 & Q5 MATCHED SET MOUNTED IN THERMAL CONTACT
8. ▽ CONNECTED TO ANALOG RET PIN 8
9. Q18 & Q19 (1007737-2) MATCHED SET IN THERMAL CONTACT
10. R13, R85 & CR1 (1007803-1) MATCHED SET
11. REMOVE FRONT BUTTON OF S1A PER 3007738 EDO B-1 FOR DD330
12. SELECT IN TEST

13. FUSE F2 LOCATED ON REAR PANEL
14. CAPACITORS ARE IN MICRO FARADES
15. REF DWG: ASSY 5007312 P/L PL5007312

NOTES: UNLESS OTHERWISE SPECIFIED

REFERENCE DESIGNATIONS	
LAST USED	NOT USED
AA2	
C42	C41
CR33	
F1	
J3	
Q22	
R108	R13, R44
S2	

PARTS LIST						
DASH NO.	BASIC	ZONE	PART NUMBER	CODE IDENT	DESCRIPTION	REFERENCE DESIGNATOR / ITEM NO.
REQD PER ASSY						

MATERIAL — HEAT TREAT — FINISH — NEXT ASSY 5007312 — USED ON DD330 DM330

CONTRACT NO. — DRAWN BY — CHECKER H.K. 9-12-69 — DESIGNER — MECH APPR — ELEC APPR — APPROVED

DYNASCIENCES CORPORATION, INSTRUMENT SYSTEMS DIVISION, A SUBSIDIARY OF WHITTAKER CORPORATION, CHATSWORTH CALIFORNIA

TITLE: SCHEMATIC - DIAGRAM ANALOG P.C.B.

SIZE E | CODE IDENT NO. 06692 | DWG NO. 660202 | SCALE NONE | WT | SHEET 1 OF 1

DWG NO. 660202 REV B

95960